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Physical Activity Awareness, Knowledge, and Behavior in College Students

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Abstract

Physical Activity Awareness, Knowledge, and Behavior in College Students

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The purpose of this project was to examine college students' physical activity awareness in relation to their knowledge and physical activity levels, as well as the factors influencing their awareness. The secondary purpose was to develop and validate an instrument for measuring college students' physical activity awareness. Three studies were conducted sequentially using a mixed-method approach.

The first study used a phenomenological perspective to understand college students' physical activity experience through focus group interview, concluding with four proposed domains that captures college students' physical activity awareness including: personal physical activity level, social support, environment, and recommendation knowledge. In addition, the results indicated a lack of self-assessment in personal physical activity and awareness of physical activity recommendations.

The second study involved multiple phases for instrument development. Participants for the content validity study were 10 experts in the field of physical activity and health. Items with unacceptable agreement (i.e. < 90%) were removed and remaining items were revised based on the suggestions of the experts. The instrument was first pilot

tested among 50 undergraduate students for item clarity and the feasibility of using the online survey, and then tested for reliability and construct validity in 994 college students. The results indicated acceptable to good internal consistency (alpha ranging from .74 to .92), and an excellent model fit.

The third study measured college students' physical activity awareness, knowledge of physical activity recommendation, and self-reported physical activity using the validated instrument in study II and explored the relationships among these variables. Effects of gender, ethnicity, major and class standing on physical activity awareness were also examined. The results suggested college students had slightly moderate levels of PA awareness in the four components (ranging from 4.21 to 5.24 out of 7), and seemly overestimated activity levels. It was found that awareness was positively associated with knowledge ($r = .220$, $p < .01$) and behavior ($r = .325$, $p < .01$), however, no significant correlations were found between knowledge and behavior. Significant major effects were found in awareness, knowledge and behavior, suggesting the role of education in raising physical activity awareness and fostering physically active lifestyles. The path analysis results also confirmed significant direct effects from all the four physical activity awareness components on total physical activity level, providing future directions for physical activity promotion in higher education settings.

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Chapter 1: Introduction

This chapter serves as the overall introduction of the entire study. Firstly, current status and issues of physical activity (PA) are briefly discussed to provide background information on this topic, followed by previous research and gaps that lead to the necessity of the present study. Rationale of the study is discussed to explain the importance of understanding college students' PA awareness in promoting healthy and active lifestyles. A roundup of the methodology is then given to identify the research questions, the scope and delimitation of the study.

Specifically, there are five chapters. Chapter one provides an overview and introduction to the study. It includes a general introduction, a rationale of the need for the study, the purpose of the study and the overview of the entire study, which consists of three projects. Research questions are also included in this chapter.

Chapter two provides a review of relevant literature. This review focuses on literature related to PA behaviors, definition of awareness, health behavior theories linking awareness with health behavior, relationships among awareness, knowledge and behavior. Because of the rarity of previous research on the topic, the literature review also includes previously applied research methodologies and measurements for assessing awareness in other health related behaviors such as smoking, binge drinking, etc. to provide a basis for the design of the current study.

Chapters three to five describe the three projects separately. Within each of the three chapters, research questions and/or hypotheses are outlined first. Theoretical framework is discussed. The sampling strategies and data collection protocol are depicted. Data analysis techniques for each research question are also addressed, followed by results and discussion. The limitations and strengths of each study are presented. The chapters end with conclusions and implications.

BACKGROUND

There has been a dramatic rise in global prevalence of overweight and obesity during the past three decades, with 27.5% increase among adults and 47.1% increase among children (Ng et al., 2014). Studies have suggested the rising obesity rate could lead to declines in life expectancy (Olshansky et al., 2005). The alarming trend has increased global concerns in public health. It is irrefutable that an adequate amount of PA has been widely recognized as an essential component of a healthy lifestyle which can help reduce childhood obesity (Department of Health and Human Service [USDHHS], 2008). Regular participation in PA is associated with numerous health benefits including reduced risks for cardiovascular disease, diabetes, cancer, hypertension, obesity, depression, osteoporosis, and premature death (Warburton, Nicol, & Bredin, 2006). In spite of increased knowledge and recognition of the contribution of PA to sound health, it was estimated in a national survey that 54.9% of the participants' monitored time was spent in sedentary behaviors in general (Matthews et al., 2008). While the World Health Organization, (WHO) recommended at least 150 minutes of moderate-intensity aerobic activity and two or more days of muscle-strengthening activities per week (WHO, 2010), only 18.2% of U.S. adults both met the muscle-strengthening guideline and were aerobically active (Carlson, Fulton, Schoenborn, & Loustalot, 2010). More alarmingly, very limited progress in increasing PA has been made during the past 10 years (Kruger, Kohl, & Miles, 2007). The gap between current PA levels and the recommended PA goals in the general population cannot be ignored. Overall, the challenge of physical inactivity remains a nationwide public health issue.

College students are a special group of young adults who will play an important role in the development of the country and have demonstrated a high risk for poor health (Anderson, Shapiro, & Lundgren, 2003; Wengreen & Moncur, 2009). In spite of the active promotion of

healthy campus by American Health Association (ACHA) for more than two decades (ACHA, 2012), many college students have adopted unhealthy behaviors due to stressful and time-consuming academic life (McArthur & Raedeke, 2009; Racette, Deusinger, Strube, Highstein, & Deusinger, 2005). Physical inactivity amongst college students has become a major health concern (ACHA, 2012), and it is most likely to maintain sedentary after graduation through adulthood (Leslie, Sparling, & Owen, 2001). The lack of PA and inappropriate diet, in addition with alcohol abuse in college may cause more serious health issues such as cancer and heart disease in later life, the top reasons for mortality and morbidity in the US (Prochaska, Spring, & Nigg, 2008).

Various PA interventions such as conceptual physical education (CPE) course have been implemented to change PA behaviors among college students (Shangguan et al., 2017), unfortunately, only marginal success has been reported (Cholewa & Irwin 2008; Leslie et al., 2001; Sailors et al., 2010; Sallis et al., 1999). Moreover, a handful of studies reported conflicting outcomes of PA interventions among college student populations. Martens and colleagues (2012) found increased PA among students after a motivational intervention. Wadsworth and Hallam (2010) found that the increase of PA faded away after six months of their study. On the other hand, some studies reported little or no impact of such interventions on student PA behaviors (Epton et al., 2014; Shangguan et al., 2017; Skår, Sniehotta, Molloy, Prestwich, & Araújo-Soares, 2011).

NEED FOR THE STUDY

The rapid increase in obesity presents educators and health practitioners with a host of challenges. Physical education (PE) provides a context for students to participate regularly in structured PA, playing an important role in students' health and wellness development. However,

the profession has faced challenges in effectively altering the populations' health behaviors (Cone, 2004). Fairclough and Stratton (2005) suggested such challenges are associated with the diverse goals of PE shared by physical educators, while the PE curriculum failed to provide valuable learning experiences that enable students to make informed decisions to maintain a healthy and active lifestyle. In other words, in order to physically educate the young generation, we need to not only provide them with PA opportunities, but also ensure that they acquire the fundamental knowledge to think critically and independently regarding their own health for the rest of their lifetime (Thompson & Hannon, 2012).

College as a transitional period from adolescents to young adults, is key to establish healthy behavior and maintenance by educating students. Many lifestyle changes take place during college years that could greatly affect PA behaviors, such as increased stress levels, physiological changes, eating behaviors, and tempting social events (Kitzrow, 2003; Racette, Deusinger, Strube, Highstein, & Deusinger, 2005; Rozin, Trachetenberg, & Cohen, 2001). In addition, social contextual factors such as communication and interaction with peers, family and environment and society within college setting can play a significant role in extrinsically motivating PA participation among college students (Fletcher, 2016).

Due to insufficient PA behavioral changes and inconsistent findings reported in previous studies examining this especially unique population, a comprehensive understanding of PA behavioral change is needed. Steckler and colleagues (2002) sketched the process of behavioral change and identified awareness as the starting point when an individual becomes aware of a problem or need, which gives an initial reason or incentive to execute certain behavioral change. Awareness could either be induced by the external forces or individual's own experiences.

Therefore, awareness seems to emerge as a critical issue in our effort to discover effective interventions that prompt PA on campus.

By examining student PA awareness and recognizing strengths and weakness of campus environment in supporting a physically active lifestyle, administrators and educators may provide timely and tailored instruction and intervention programs that meet the unique educational and cultural context in college settings. Moreover, by recognizing multiple factors in PA awareness, college students can develop their own strategies for achieving the internationally recommended PA goals to help maintain their fitness.

RATIONALE OF THE STUDY

Three projects were conducted to examine PA awareness among college students. The primary purpose of the first two studies was to develop a valid and reliable instrument to assess college student PA awareness level including self-evaluated PA, recognition of recommended PA goals and the environmental factors. The secondary goal, which was accomplished in the third study, was to determine college students' PA awareness levels in gender, major, and class standing.

The goal of PE is to prepare students with essential knowledge and skill to maintain a physically active lifestyle, associated with desired fitness level for a better health. Thus, PE should help students achieve awareness, knowledge, attitude and responsible behavior about PA and healthy behaviors. PA knowledge is a fundamental part as it provides the foundation for any practice. Awareness is the perception of knowledge and the use of that knowledge. While various PE classes have been offered in college to physically educate students including to increase PA behavior (Keating, Wallace, Schafer, O'Connor, Shangguan, & Guan, 2012), college students, who may not have an appropriate understanding of PA, oftentimes tend to presume that they

already have sufficient "common" knowledge about PA or even believe that such courses are simplistic and unnecessary (Coelho, 2000; Mack, Mick, & Shaddox, 2005; Wilson & Dunn, 2004). More alarmingly, previous research examining PA knowledge has provided disappointing results, including insufficient mastery and misconception of such knowledge (Desmond, Price, Lock, Smith, & Steward, 1990; Hopple & Graham, 1995; Keating, Harrison, Dauenhauer, Chen, & Guan, 2009b; Kulinna, 2004; Merkle & Treagust, 1993; Placek et al., 2001; Stewart & Mitchell, 2003). Therefore, increasing PA awareness (i.e., PA knowledge and application of knowledge) on campus might be an important first step that allows students to acknowledge their weakness and missing pieces in PA behavior as well as discover essential PA-facilitating elements that are tailored towards their own lifestyle.

The lack of PA awareness among college students not only hinders our investigation on how knowledge affects PA behaviors, but also reduces our confidence to advocate for PE requirement in college. According to more recent health research, it is believed that behavior change as a multi-step process, only initiates with an adequate amount of awareness and knowledge (Kay, Carroll, Carlson, & Fulton, 2014). Researchers found positive relationships among awareness, knowledge, and behavior (Choudhary et al., 2016; Pereral et al., 2014). For example, according to the theory of self-awareness (Duval & Wicklund, 1972), accurate information regarding knowledge and self-evaluation are found to be critical elements in order to raise health awareness that further translate into behavioral change (Lechner, Bolman, & van Dijke, 2006; Ridder, & Lechner, 2004; van Sluijs, Griffin, & van Poppel, 2007). However, to the best of our knowledge, no studies have been reported in PA research with the attempt to thoroughly examine PA awareness among college students using quantitative approaches.

The potential contribution of this study to the PA awareness literature is threefold. First, assessing the level of PA awareness could provide preliminary knowledge of to what extent current college students understand the importance of PA in maintaining health. Second, understanding student PA awareness relevant to the college setting as a unique context could gather more information to plan and implement intervention programs that directly addresses barriers that hinder healthy behaviors. And third, the results of this study may lead to a further step of raising PA awareness among students, administrators, health practitioners and policy makers to work together using empirical college student PA awareness data.

OVERVIEW OF THE RESEARCH DESIGN

Overall, the present study used a mixed-method approach aiming to measure and examine PA awareness among college students (Figure 1). Due to the sparsity of established research on this topic, qualitative methods were firstly applied to explore how college students make sense of PA awareness, which informed relevant domains of the quantitative measurement. Based on self-awareness theory and social ecological model, quantitative measures were developed and analyzed to provide a comprehensive understanding of student PA awareness situated in the college setting.

In essence, a phenomenographical approach was employed through focus group interviews of college students, which was Study I. The qualitative results were analyzed and synthesized to provide guidance for domain and item construction in the instrument development phase. Based on the results found in Study I, Study II focused on developing an instrument measuring college student PA awareness. The instrument consisted of two independent sections: (a) a questionnaire based on social ecological model that measures PA awareness of individual, social, and environmental factors on 7-point Likert scale; and (b) a test on PA recommendation

knowledge. The instrument was tested for its validity and reliability through factor analysis. Study III was designed to compare PA awareness and behavior across different groups of college students.

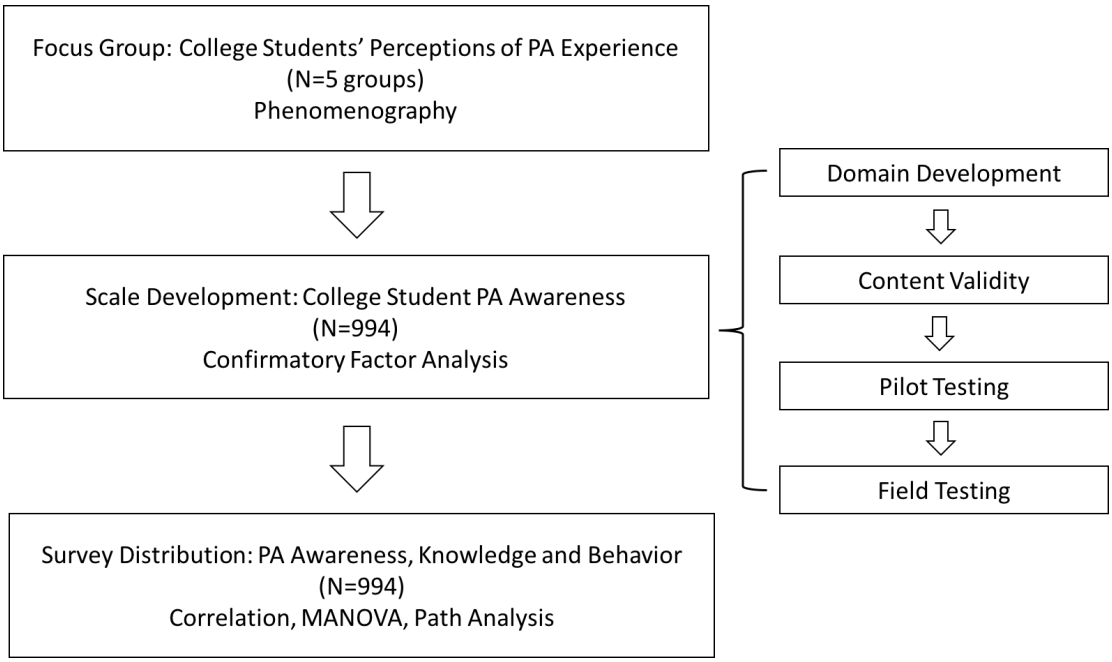

Figure 1: Conceptual Framework of the Sequential Mixed-method Design.

Research Questions

The overarching research question was to examine college student PA awareness. Based on the purposes of the first study which aimed to gain a brief understanding of how college students make sense of PA and raising PA awareness in their personal experience, two research questions were formulated to guide the phenomenographical interviews.

1. How do college students become aware of their own PA behaviors and PA-related factors in college settings?
2. What are the domains of college students' PA awareness?

The second study aimed to develop an instrument to measure college student PA awareness guided by psychometric theories (Cook & Beckman, 2006). This included two types of measurements. The first part of the instrument measured self-perceived PA awareness of various factors on a Likert scale. The second part used a 4-item multiple choice knowledge test to measure students' actual knowledge of PA recommendations. Therefore, the research questions were:

1. What items adequately capture the various aspects (i.e. social ecological factors) of college students' PA awareness?
2. What are the validity and reliability of the scale designed to measure college students' PA awareness?

The third study aimed to examine levels of college student PA awareness, as well as PA awareness differences in gender, ethnicity, major, and class standing. It was hoped to examine multiple interactive relationships among PA awareness, knowledge and behavior to understand the relations among the above three factors. Therefore, the following research questions were developed to guide the third study.

1. What are the effects of gender, ethnicity, major, and class standing on students' PA awareness?
2. What are the relationships among PA awareness, PA knowledge and PA behavior?

Scope and Delimitation of the Study

1. The study only involved full-time students at four-year colleges.
2. The study only examined knowledge of the PA recommendation in order to maintain healthy levels as suggested by the WHO.

3. This study only assessed cognitive aspects of PA awareness. While awareness of standard knowledge was assessed against the criterion with correct answers, all measurements regarding awareness of self and environment are based on participants' self-perception. Therefore, PA behaviors were measured using self-reported data.

Chapter 2: Review of Literature

In this chapter, relevant literature pertaining to PA awareness, and influencing factors such as knowledge, as well as the associations among knowledge, awareness, and behavior was presented. This chapter functions as a condensed review of the previous literature to provide a broader perspective on the concepts of this study. The selection of methodologies was also stemmed in the thorough literature review on existing studies on the topic.

In order to help readers fully understand the study, definitions of awareness were first discussed and domains of awareness were then identified. The theory of self-awareness was introduced to illuminate the relationship between knowledge and awareness, and how the two components interact to trigger behavior change. The significance of awareness was discussed in relation to widely used health theories by depicting how awareness plays a critical role in health behaviors. Following a brief discussion on PA definition and health benefits, gaps between PA promotion on campus and current status of PA were identified, suggesting the critical role of awareness in affecting individual's PA behavior. The significance of awareness in influencing health behaviors was demonstrated in three health behavior theories that have been widely used in the literature. The last section of the review focuses on methodology issues used in previous studies for assessing health-related awareness, followed by implications for the present study due to the lack of research on the topic. The chapter concludes with a summary of issues in previous research and proposes a study that will help to fill the gap in existing findings.

AWARENESS

> "The aim of life is to live, and to live is to be aware – joyously, drunkenly, serenely, divinely aware".
>
> -Henry Miller

Definition of Awareness

It is imperative to start with clear definitions. Awareness is a broad term and the meaning varies to different individuals. However, the general concept of awareness refers to common knowledge or understanding about an internal state or external environments. Awareness is the means through which the behavior may be regulated by choice and involves components ranging from internal states to external events. It is the full recognition of individuals' experience: what we feel about ourselves and what is happening around us. The concept of awareness has been mostly articulated by scholars in Gestalt psychologists. Polster and colleague (1974) described awareness as "a continuous process for keeping up to date with one's self" (p. 211). Yontef (1993) stated awareness as "a form of experience that may be loosely defined as being in touch with one's own existence with what is (p. 144). Dourish and Bly (1992) define awareness as an understanding of the activities of others, which provides a context for your own activity. Greenhaus and colleagues (2009) defined awareness as a relatively complete and accurate perception of one's own qualities and the characteristics of the environment.

In summary, awareness is a dynamic process of making sense of one's self and the outside world. Awareness, together with responsibility are significant factors on the road to behavior change. A behavior cannot be owned without awareness, leaving no space for the power of choice and responsibility. It is through the raise of awareness of current experiences that an intentional change might possibly be triggered. Awareness involves actively identifying, processing and reflecting on information collected by oneself. It is a multidimensional concept that contains various domains.

Domains of Awareness

Although awareness as a term has been used regularly in the literature, a widely accepted definition of awareness is still not available. Perl (1969) named three zones of awareness: the inner, middle and outer zones that are inextricably linked and overlap. The inner zone oftentimes refers to awareness of the bodily sensations and feelings. The middle zone involves internal and external stimuli that are organized into memories, thoughts and imagination in order to make meanings and choices. The outer zone includes awareness through contact with the outer world by ways the five senses: seeing, hearing, speaking, touching, smelling and moving (Joyce & Sills, 2006; Perl, 1969). Polster and colleague (1974) identified four aspects of awareness: awareness of sensations and actions, awareness of one's feelings, awareness of wants, and awareness of values and assessments. More importantly, awareness may be categorized as self-awareness and environment awareness, both of which have been identified as critical component of decision making and behavior management (Dourish & Bly, 1992; Duval & Wicklund, 1972; Greenhaus et al., 2009).

Self-awareness

According to the self-awareness theory (SAT) (Duval & Wicklund, 1972), self-awareness refers to the capacity of becoming the object of one's own attention that allows an individual to self-focus and then self-evaluate by automatically comparing the self against specific standards on how the individual should think, feel and behave. This process is a critical mechanism of self-control as it increases the tendency to change one's behavior. Furthermore, SAT suggests an optimal state of consistent comparison between self and a set of standards, leading to the recognition of discrepancies as well as negative outcomes. In this case, self-awareness plays an

important role in facilitating the motivation for positive behavioral response in order to reduce the recognized discrepancies. On the other hand, more recent research identified two other decision-making choices in the self-evaluation process as a response to heightened self-awareness: escape or change standard (Morin, 2003). When a large discrepancy is identified, instead of reducing the discrepancy, an individual may avoid self-awareness, which might be prevented through presence of positive expectancy and progress. Alternatively, individuals reduce discrepancies by modifying their standards instead of the self as they attribute the cause of discrepancy to the standard (Morin, 2003). It is also suggested in the SAT that individuals with increased private self-consciousness have better understanding of their internal process and more differentiated concept of their personal values (Shrum & McCarty, 1992). Meanwhile, individuals with raised public self-consciousness are more likely to seek an approval from others (Doherty & Schelenker, 1991).

There has been confusion between "consciousness" and "self-awareness" (Antony, 2002). A classic distinction was proposed by Mead (1934), between outward attention toward the environment and inward attention toward self. A conscious organism processes incoming information from the environment and respond to it adaptively without cognitively recognizing such a response (Natsoulas, 1996). While self-awareness involves reflecting on the experiences of perceiving and processing information about self and environment. Therefore, self-awareness represents a high level of consciousness. Additionally, an ultimate level of self-awareness is referred as meta-self-awareness – being aware that an individual is self-aware (Morin & Everett, 1990).

Environment Awareness

Environment awareness can be characterized as perception of opportunities, constrains, and challenges relevant to the outside world, for instance, rules and standards (Gustat et al., 2014). In regard to PA, the presence of certain environmental features such as active transportation and proximity to PA facilities have shown positive associations with PA participation as they provided more PA opportunities that could be incorporated into one's daily life (Casagrande, Whitt-Glover, Lancaster, Odoms-Young, & Gary, 2009; Fishman, Boecker, & Helbich, 2015; Kaczynski & Henderson, 2008; McCormack et al., 2004; Reed & Ainsworth, 2007; Waygood, Owen, & Sun, 2015). A handful of studies have suggested the influence of environment on PA patterns of individuals who live and work in communities (Durand, Andalib, Dunton, Wolch, & Penz, 2011; Heath et al., 2012; Owen, Humpel, Leslie, Bauman, & Sallis, 2004). It is also indicated that perceptions of the environment (i.e. presence, access, quality, and safety) played a significant role in one's PA (Sallis, Floyd, Rodriguez, & Saelens, 2012; Reed & Ainsworth, 2007). College students, while spending a great deal of time on campus, are a special group of population whose PA and sedentary behaviors are highly associated with the specific environmental attributes (Ford & Torok, 2008; Kapinos & Yakusheva, 2011; Roemmich, Balantekin, & Beeler, 2015).

Evidence has also suggested the effects of psychosocial factors in the environment on one's PA behavior, including social support and action planning (Kahn et al., 2008; Li, Iannotti, Haynie, Perlus, & Simons-Morton, 2014; Zook, Saksvig, Wu, & Young, 2014). The characteristics of social support in the environment include encouragement, companionship, assistance from friends/peers/families, advice from professionals, as well as information and service from community/organization (McNeil, Kreuter, & Subramanian, 2006).

According to the self-regulation theory of self-awareness, an individual's attention is mostly directed towards the environment in daily life, resulting in automatic and habitual behavior without being aware of personal attributes (Carver & Scheier, 2012). Therefore, the environment may trigger self-awareness and behavior change. The relationship between self-awareness and environment awareness, however, has not been studied in previous literature.

PHYSICAL ACTIVITY

Definition of PA

PA is defined as any bodily movement produced by skeletal muscles that requires energy expenditure (Caspersen, Powell, & Christenson, 1985). It is often times used interchangeably with "exercise", which only represents a subset of PA that is planned, structured, repetitive and purposive in order to achieve a certain level of physical fitness. While physical fitness is a set of attributes that people have to carry out daily tasks. Both PA and exercise are positively associated with physical fitness as the frequency, intensity, and duration of the movements increase (Caspersen, Powell, & Christenson, 1985). PA is a complex behavior, as a result, it is branched into different categories in daily life, including occupational, sports, conditioning, household, and other activities. However, these categories are not necessarily exclusive of each other. It is also acceptable to divide PA into light, moderate and vigorous (Caspersen, Powell, & Christenson, 1985).

PA and Health

Research has suggested that PA on a regular basis can help prevent diseases such as diabetes, cancer, and cardiovascular disease (Reiner, Niermann, Jekauc, & Woll, 2013). In order to achieve a well-built health, the benefits of PA and nutrition on health and fitness cannot be overstated, with presence of comprehensive recommendations for health-related PA by numerous health organizations (Haskell et al., 2007; Krauss et al., 2000; US Department of

Health and Human Services [USDHHS], 2008). According to the Center for Disease Control and Prevention (CDC) and the American College of Sports Medicine (ACSM) (2011), in order to maintain good health, all healthy adults aged 18-65 years old need moderate-intensive aerobic activity for a minimum of 30 min. on five days each week or vigorous-intensive aerobic activity for a minimum of 20 min. on three days each week. Moreover, further research recommended that adults perform muscle-strengthening activities for a minimum of two days each week (Haskell et al., 2007). Despite the clear guidelines on PA and the assumption that adherence to the guidelines would result in health benefits, a great number of adults in United States are not physically active. More specifically, PA levels are consistently low among women, older adults, racial minority groups, and low SES populations (CDC, 2005). According to the 2003-2004 National Health and Nutritional Examination Survey (NHANES), adherence to the 30 min. per day PA recommendation was reported to be less than 5% among adults (Troiano et al., 2008). Moreover, PA levels gradually decline along with age among most adults, especially among females (Butt, Weinberg, Breckon, & Claytor, 2011). The CDC reported only half of all adults in the U.S. achieved health-enhancing levels of PA (CDC, 2015).

Prevalence of PA among College Students

The American College Health Association's annual National College Health Assessment (ACHA-NCHA-II, 2010) reported that over 70% of college students did not meet the recommended amount of moderate aerobic exercise, while more than 85% were not meeting the recommendation for muscle-strengthening activities. Researchers suggested that students who live in campus dormitories with an easy access to commercially prepared food were more likely to adopt poor dietary behaviors such as insufficient intake of fruits and vegetables (Greene et al., 2011; Huang et al., 2003; Irwin, 2004; Kapinos & Yakusheva, 2011). Particularly, male students

that live in dormitories with a dining hall may have more frequent meals and snacks. Additionally, female students living in dormitories were found to exercise less (Kapinos & Yakusheva, 2011).

College is a key transitional period for young adults during which they face challenges adjusting to new environments with lifestyle change and greater freedom (Wengreen & Moncur, 2009). Many freshmen adopted unhealthy behaviors such as the lack of PA, insufficient amount of sleep, excess caloric intake, and low intake of fruits and vegetables (McArthur & Raedeke, 2009; Racette, Deusinger, Strube, Highstein, & Deusinger, 2005). Such behavioral changes were adopted by many freshmen due to stressful and time-consuming academic activities (Buckworth & Nigg, 2004; McArthur & Raedeke, 2009; Racette et al., 2005). These unhealthy behaviors are often associated with health problems such as excessive weight gain that could lead to obesity with other health consequences in their later life (Anderson, Cohen, Naumova, Jacques, & Must, 2007; Must & Strauss, 1999; Reilly et al., 2003).

The college setting is a unique environment equipped with a variety of fitness programs and facilities, which potentially makes it a great place with multiple opportunities to help promote students' health and fitness. Previous research findings suggested that the establishment of healthy lifestyle during college years is beneficial to the maintenance of a healthy life after graduation (Keating, Guan, Castro-Pinero, & Bridges, 2005; McArthur, & Raedeke, 2009). The American College Health Association (ACHA) (2012) has actively advocated for a healthy campus for more than two decades. Despite the various efforts that promote physically active lifestyle and healthy dietary intake on campus, nearly 80% college students in the United States fail to achieve the recommended levels of PA. Consequently, their PA levels tend to deteriorate throughout their college period with the presence of risky health behaviors, and this puts the

college students at a greater risk level of poor health (Huang et al., 2003; Kolodinsky, Harvey-Berino, Berlin, Johnson, & Reyonlds, 2007; Morrow et al., 2006; Racette, Deusinger, Strube, Highstein, & Deusinger, 2008; Vella-Zarb & Elgar, 2009; Weinstock, Capizzi, Weber, Pescatello, & Petry, 2014).

In summary, there is an urgent need to implement effective PA interventions on campus to help college students establish a healthy and physically active lifestyle. Physical education, in particular, has the potential to instill essential PA knowledge, with which students are able to become aware of their own PA by reflecting on personal behaviors, recognizing the lack of PA in their daily life, and analyzing various factors to identify strategies that help avoid sedentary behaviors and foster active campus atmosphere**.** Therefore, it is imperative to understand how knowledge and awareness work together influence college student PA behaviors.

KNOWLEDGE AND AWARENESS OF PA

PA Knowledge

According to Vega and colleagues (1987), knowledge is one of the necessary factors for behavioral change to occur. Although knowledge alone is not sufficient to alter an individual's behavior (Morrow, Krzewinski-Malone, Jackson, Bungum, & FitzGeralk, 2004), it is a required element when it comes to decision making in health-related behaviors (Parcel & Baranowski, 1981; Rudd & Glanz, 1990; Sontag-Padilla et al., 2018). Sallis and Hovell (1990) suggested that health and exercise knowledge had predictive effects on PA and maintenance. They furthermore implicated that the importance of "how to" knowledge played a significant role to promote PA rather than the "benefit" knowledge (Sallis & Hovell, 1990).

It is extremely important to understand the principles and concepts of PA as this knowledge was found to positively associate with PA participation and healthy eating. Therefore, it contributes to a physically fit lifestyle (Adams, Graves, & Adams, 2006; Heinrich, Maddock, & Bauman, 2011; Keating, Harrison, Dauenhauer, Chen, & Guan, 2009; Misra, 2007; Office of Disease Prevention and Health Promotion, 2013; Zhu, Safrit, & Cohen, 1999). Thus, the mastery of knowledge becomes an important aspect of quality physical education as it may potentially increase PA and fitness among adolescents (CDC, 2000; Merkle & Treagust, 1993; Stewart & Mitchell, 2003).

However, efforts are not enough in many physical education programs in order to meet the educational goal of teaching fitness knowledge to students (Ferguson, Keating, Guan, Chen, & Bridges, 2007; Keating, Chen, Guan, Harrison, & Dauenhauer, 2009*;* Kulinna, 2004; SHAPE America, 2014). Prior to college, students are expected to possess a sound level of PA knowledge, presuming K-12 physical education has prepared them to be "physically educated" based on the national physical education teaching standards (SHAPE America, 2014). Unfortunately, previous research on PA knowledge among pre-college adolescents demonstrated a prevalence of inadequate knowledge (Desmond, Price, Lock, Smith & Stewart, 1990; Keating et al., 2009; Merkle & Treagust, 1993; Stewart, & Mitchell, 2003; Thompson & Hannon, 2012; Williams, Phelps, Laurson, Thomas & Brown, 2013).

Furthermore, previous studies examined college students' PA knowledge as well as its relationship with actual PA participation, reporting no significant correlations between the two variables (Keating et al., 2010; Knox et al., 2012; Maddock, Marshall, Nigg, & Barnett, 2003; Ward, 2014). Similar findings have been reported in K-12 settings (Budd & Volpe, 2006; Kropski, Keckley, & Jensen, 2008). Possible reasons for the gap in theoretical relationships

between PA knowledge and PA behaviors have been discussed by researchers, including the lack of valid and reliable knowledge tests for students in general; and the timely updated PA knowledge that matches with most recent knowledge on the topic (Keating et al., 2009).

Physical Activity knowledge and behavior are key determinants of an individual's physical fitness and health (Heinrich et al., 2011; O'Donovan et al., 2010). A health-literate individual needs to understand how to interpret and evaluate the information in the society to make appropriate choices. In order to do so, an individual should be able to access health-related information and have the capacities to assess the accuracy and validity of such information (Zarcadoolas, Pleasant, & Greer, 2006). It has been suggested that PA knowledge is a critical factor that influences individuals' PA and dietary behaviors (Nelson, Kocos, Lytle, & Perry, 2009). With sufficient PA knowledge, a college student should be capable of incorporating regular PA and healthy choices in daily life in order to maintain desired level of fitness and health that could be extended to later adulthood. Unfortunately, despite recommendations on PA by health professionals and various attempts promoting the guidelines, the average college student remains physically inactive (Racette et al., 2008). Research has also suggested that knowledge needs to be constantly reinforced through education to raise awareness, so it may be efficiently converted into practice (Trepka, Murunga, Cherry, Huffman, & Dixon, 2006). This calls for a change in college students' PA behavior. College years as the transitional period from late adolescence to early adulthood appear to be essential time for effective behavioral intervention, highlighting the need for research in effective approaches to affect college students' PA behavior because it is the last educational opportunity to change PA behaviors in a large segment of young adults (Keating et al., 2012; Shangguan et al., 2017).

PA Awareness

Despite the comprehensive objectives of physical education in attempt to educate students for a healthy lifestyle, it may not be realistic for all students to achieve a mastery level of all the knowledge and skills (Thompson & Hannon, 2012). While PA knowledge permits accurate decision making, awareness, without which behavioral change is less likely to succeed, is a great place to plant the seed. It is deemed crucial to equip students with the insight that awareness is important and helps them develop awareness so they could adopt desired PA behaviors in various environments. Research examining PA awareness has been sparse, therefore, due to rarity of studies on this topic, this part of literature review only includes previous research on awareness related to other constructs such as health, nutrition, etc.

It is necessary to point out that awareness has not been well defined and there is not a widely accepted definition of awareness, even though a number of studies have examined the topic of awareness in general. In a number of health behavior studies, awareness not only refers to the inner recognition and evaluation of an individual's personal level of health behavior and related risks and symptoms, but also refers to one's inter-relationships with recommended behaviors and environmental factors that may influence decision making (Bogers et al., 2004; Eckel et al., 2009; Mosca et al., 2006; Pereral et al., 2014; van Sluijs et al., 2007). In studies investigating the relationships among awareness, knowledge and behavior, it is found that awareness is positively associated with related knowledge and behavior (Choudhary et al., 2016; Mosca et al., 2006; Pereral et al., 2014). In addition, awareness and knowledge are significant predictors of behavior change (Campbell, 1999; Neill, Wise, & McLeish, 2000; Stables et al., 2002). More importantly, the raise of health awareness should be based upon valid self-assessment in order to provide useful implications for positive behavioral change, which relies

on the accuracy of health-related knowledge. On the other hand, awareness grounded on misperceptions may act as a barrier to behavior change (De Ridder & Lechner, 2004; Lechner et al., 2006; van Sluijs et al., 2007). For example, it was found that those who were younger and less educated tend to overestimate their PA levels, thus, are less likely to improve their PA behavior (De Ridder & Lechner, 2004).

In the "information-motivation-behavioral skills model" proposed by Fisher and Fisher (1992), knowledge, although necessary yet not sufficient to cause desired behavioral outcomes, is suggested to have a jointly impact with motivation to alter individuals' behavior through direct and indirect effects on behavioral skills. More specifically, such influence of knowledge on behavior has been inconsistent and relatively small (Fisher, Fisher, Williams, & Malloy, 1994; Keating et al., 2009; Misovich, Martinez, Fisher, Bryan, & Catapano, 2003). Although studies have indicated that unhealthy lifestyle behaviors are often times associated with lack of health knowledge (Steptoe & Wardle, 2001), it is commonly accepted by researchers that the possession of accurate health information does not directly lead to effective actions in studies examining health-related behaviors and decisions (Feeley & Servos, 2005; Guerra, Dominguez, & Shea, 2005; Ievers-Landis et al., 2003; Silver Wallace, 2002). Using mathematical equation modeling in attempt to predict nutrient consumption, Variyam and colleagues (1995) investigated the effect of nutrition information on individuals' dietary intake, finding that awareness, knowledge and attitude play key roles in dietary consumption; furthermore, they concluded that the influences of awareness and attitudes on dietary behavior were stronger than the influence of knowledge (Variyam, Blaylock, & Smallwood, 1995).

Meanwhile, contradictory results have been reported regarding the relationships among awareness, knowledge and behavior. Gerend and Magloire (2008) assessed levels and correlates

of awareness, knowledge and beliefs about human papillomavirus (HPV), as well as interest in HPV education and vaccine among 124 college students and concluded low levels of HPV knowledge in conjunction with low perceptions of risk weakened students' efforts to prevent HPV infection. However, higher level of knowledge and awareness might not translate into actual preventive behaviors (Gerend & Magloire, 2008).

In summary, research on the topic is still at its infancy given that few studies on the topic have been reported. In order to help readers fully understand this strand of research, the literature of awareness of other constructs was reviewed to shed new lights on PA awareness. Overall, the relationship between health-related awareness and health behavior has been unclear depending on the specific topics (Gerend & Magloire, 2008; Steptoe & Wardle, 2001). Researchers specifically suggested that it is difficult to examine determinants of awareness, as the direction of causality between awareness and its related factors could be uncertain to determine (van Stralen, Lechner, Mudde, De Vries, & Bolman, 2010). However, it is suggested by researchers that a lack of awareness may limit people's positive behavior change and the effectiveness of health-promoting interventions (De Ridder & Lechner, 2004; Lechner, Bolman, & van Dijke, 2006; Ostchega, Dillon, Hughes, Carroll, & Yoon, 2007).

SIGNIFICANCE OF AWARENESS IN HEALTH BEHAVIORS

Awareness, a relatively complete perception of an individual's self and surrounding environment, though is not demonstrated in its literal form, has been presented as a critical construct in various health behavior theories in attempt to predict behavior change through its effect on intention and motivation (Azjen, 1991; Bandura, 1986; Prochaska & DiClemente, 1983). This section will cover brief discussions on the significance of awareness on health behavior as depicted in three frequently used health behavior models including Health Belief

Model, Transtheoretical Model and Theory of Planned Behavior. The role of awareness in initiating behavior change is explained through its contribution in the execution of each model.

Awareness in Health Belief Model

The development of Health Belief Model (HBM) was derived from assessments of health risk in relation to health behaviors by public health professionals in the 1950s (Hochbaum, 1958; Rosenstock, 1960). In the HBM, five factors contribute to disease prevention behaviors, which includes: perceived susceptibility, a person's beliefs about the possibility of being harmed by the health condition; perceived seriousness of the consequences of the health condition such as mortality; perceived benefits of performing recommended behavior such as healthier life; perceived barriers to the suggested behaviors such as time and cost; and cues to action that elicits individuals' readiness to perform healthy behaviors (Janz & Becker, 1984). The application of the HBM has been well documented in examining PA (Dolman & Chase, 1996; Juniper, Oman, Hamm, & Kerby, 2004; Sorensen, 1997).

In addition, motivation and salience were suggested to be mediators, providing individuals' own sense of participation and responsibility for their health (Chew, Palmer, Slonska, & Subbiah, 2002). Health motivation refers to a general predisposition toward health and assesses the degree of involvement in related health behaviors. It is also associated with health beliefs and intentions (Rosenstock, 1974). Salience refers to perceived psychological distance between good health and an individual's own health. Using the HBM with the two additional mediators, Chew and colleagues (2002) examined the impact of a health promoting television program on health knowledge and HBM factors, as well as health-related behaviors including exercise, nutrition, and smoking. The results indicated that increased health knowledge may lead to higher efficacy and salience, which would further promote healthy behaviors. In

addition, participants with higher confidence levels in assessing the accuracy of their health knowledge were more likely to engage in healthy behaviors.

Therefore, it is suggested that awareness, when referring to perceived consequences on an individual's own health, as well as the distance between self behavior, and PA recommendation (salience), may increase the individual's own responsibility and motivation to engage in more health-promoting activities. Accuracy of PA knowledge on self and standards may also play a positive role in making healthy decisions. The role of awareness in HBM is illustrated in Figure 2.

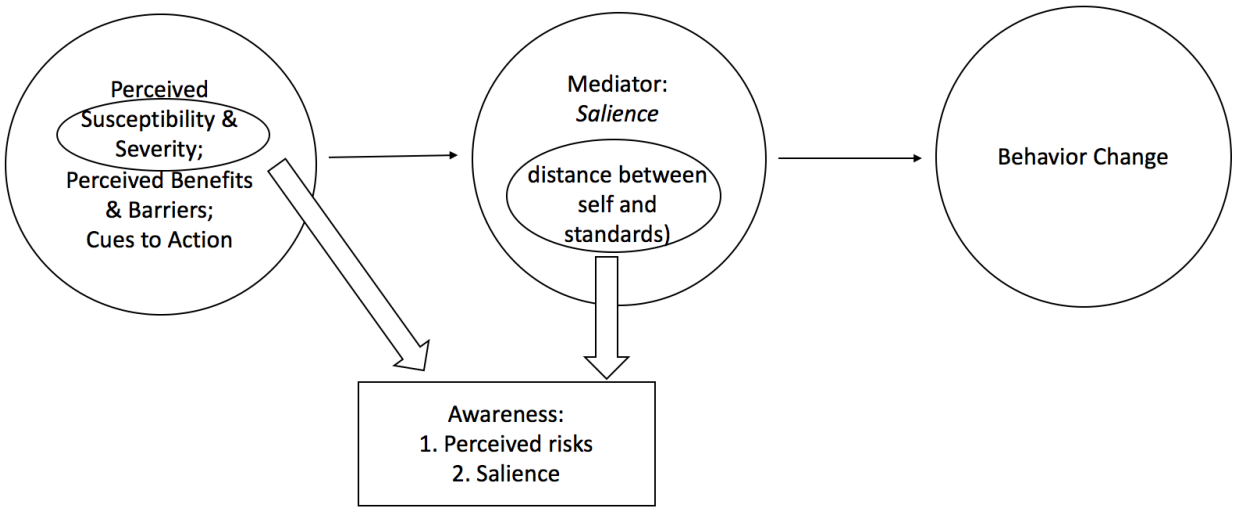

Figure 2: Role of Awareness in Health Belief Model.

Awareness in Transtheoretical Model

Health behavior change is a dynamic process. According to the transtheoretical model (TTM), human behavior occurs in stages of change over time (Prochaska & DiClemente, 1982). The TTM consists five stages of behavior change: precontemplation (a person has no intention to change the behavior), contemplation (considering behavior change), preparation (intend to

change), action (actual change) and maintenance (sustained behavior change). It was also suggested that intervention programs are necessary at all stages in the TTM and should be tailored for each stage for optimal effectiveness (Campbell et al, 1994). Various changing processes occur as individuals navigate through the stages, including consciousness raising, dramatic relief, self and environmental reevaluation, self-liberation, helping relationships, counterconditioning, reinforcement management, stimulus control, and social liberation (Prochaska, Redding, & Evers, 2002). More specifically, consciousness raising refers to individuals' awareness of a negative behavior and consequences; self and environmental reevaluations refer to assessment of that may serve as a motivating factor; helping relationships refers to social support; stimulus control refers to monitoring the environment to reduce temptations; social liberation refers to resources existing in the environment that encourages healthy behavior (Prochaska, Redding, & Evers, 2002). In the continuum of process of behavior change, general knowledge and awareness are a necessary first step in taking action but may not be sufficient (Mosca et al., 2006; Prochaska, DiClemente, & Norcross, 1992).

In interpreting an individual's ability to resist temptation for unhealthy behavior, self-efficacy theory was incorporated into the TTM (Bandura, 1982). Developed out of multiple psychotherapy and behaviorist theories, the TTM has been applied to study various health behaviors including PA, nutrition, smoking and risky sexual behaviors (Lechner, Brug, & De Vries, 1997; Lechner, Brug, De Vries, van Assema, & Mudde, 1998; Plotnikoff, Hotz, Birkett, & Courneya, 2001; Prochaska, Redding, & Evers, 2002; Ronda, van Assema, & Brug, 2001). One of the important implications from previous TTM studies revealed that when there is a lack of appropriate knowledge, individuals tend to have distorted perception of their own behavior, thus, less likely to initiate a change. In the meanwhile, awareness of unhealthy behavior is suggested

to be especially important to proceed from pre-contemplation to contemplation stage (Weinstein, 1988). More specifically, those who were not aware of PA and dietary recommendations had a skewed view of their own behaviors and were consequently not achieving recommended levels of PA and nutritional consumptions (Lechner et al., 1997; Ronda et al., 2001). For college students, temptations from peers and the campus environment play great roles in altering one's change process and stage of change (Nelson et al., 2009). In addition, students need to be aware of the benefits of developing sound personal fitness through regular participation in PA and adequate nutrition, outweigh the time and effort it takes, so that such fitness patterns can be integrated into their daily routine (Conner, Sandberg, & Norman, 2010).

Studies using TTM in health behavior have three implications. First, it is important for college students to build the awareness on the benefits of sound personal fitness through regular participation in PA and adequate nutrition. In addition, it is equally important to have the awareness of surrounding PA resources on campus to increase students' self-efficacy that allows them to outweigh the time and effort, so that individualized fitness patterns can be integrated into their daily routine. Lastly, it is encouraged that college students keep self-monitoring and self-evaluating one's own PA against recommended PA levels for behavior maintenance. The role of awareness in HBM is illustrated in Figure 3.

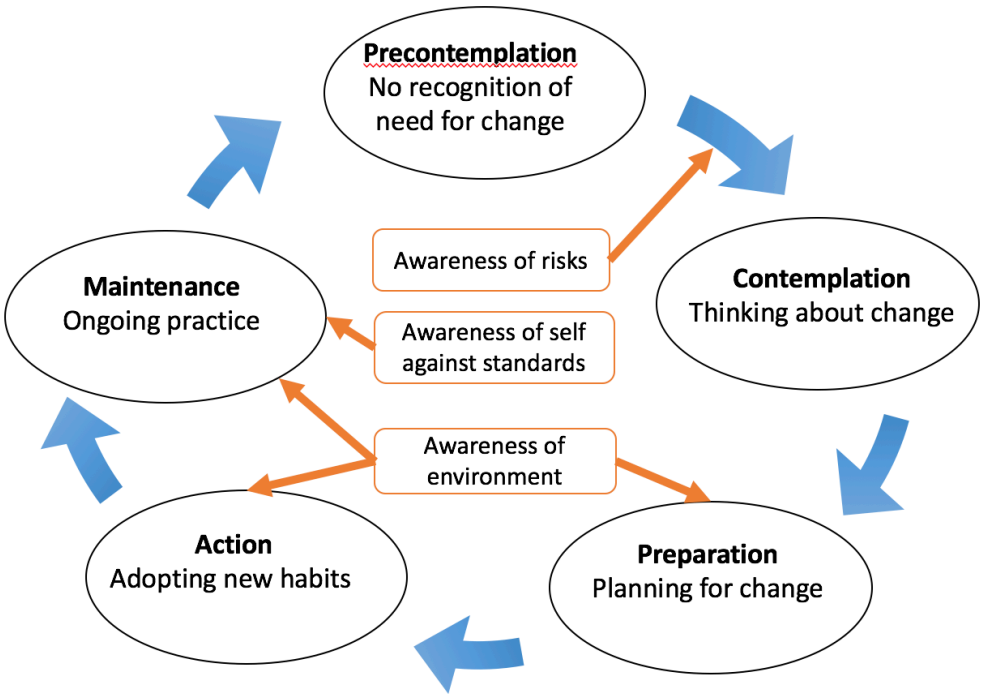

Figure 3: Role of Awareness in Transtheoretical Model.

Awareness in Theory of Planned Behavior

Developed from the Theory of Reasoned Action (Fishbein & Ajzen, 1975), the Theory of Planned Behavior (TPB) proposed by Ajzen (1991) noted that the intention to perform or not to perform a behavior determines the occurrence of the behavior. Intention is controlled by attitude toward the behavior, the subjective norm (perceptions of social pressure to perform the behavior), and perceived behavioral control (perceived ability to perform the behavior). In particular, knowledge may impact individuals' attitudes, which in turn affect intentions toward behavior (Spiegel & Foulk, 2006). The TPB has provided guidance for research in PA and health-related behaviors (Chatzisarantis & Hagger, 2005; Hagger, Chatzisarantis, & Biddle, 2002; Jackson, Smith, & Conner, 2003; Rosemary, McEachan, Myers, 2010). In a meta-analytic

review of 79 studies (Hagger et al., 2002), it was reported that the TPB accounted for 44.5% of the variance in PA intention and 27.4% of the variance in PA behavior.

Habitual Behavior. It is assumed that behavioral change takes place in a sequence followed by awareness of a problem or need is raised (Steckler et al., 2002). When the problems or needs are routine, standard actions are followed and awareness hardly occurs, which is known as habitual behavior (Cyert & March, 1992). However, if the problem is new, knowledge of alternatives is evaluated and an attitude is formed to make the decision, which further leads to actual behavioral change. When the advantages of the planned behavior constantly outweigh the disadvantages, it develops into a habit. The mechanism is illustrated in Figure 4. It is suggested that habitual behavior can be influence by breaking the "evaluation loop". One important strategy is to make individuals aware of habitual behavior.

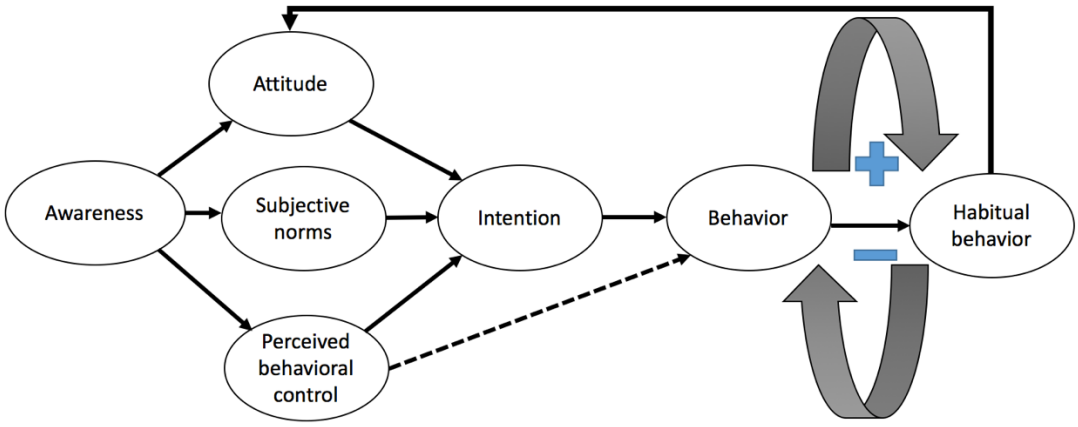

Figure 4: Role of Awareness in Theory of Planned Behavior.

According to Weistein (1998), an individual's intention of health behavior change is determined by two factors: (a) the belief on health benefits or reduced health risks caused by behavioral change; and (b) the awareness of the individual's own "unhealthy" behavior. In other

words, awareness of positive influence of a desired behavior on health risks associated with stronger positive beliefs of that behavior, leading to higher levels of healthy behavior (Näslund, 1997). It has also been shown in studies that lack of awareness on one's health behavior could decrease the predictive value of the TPB (Bogers, Brug, van Assema, & Dagnelie, 2004).

In summary, based on aforementioned health behavior theories, it is assumed that awareness of insufficient PA is the first phase of PA behavior change as individuals consider behavior change only after they become aware of their unhealthy behavior (van Stralen, Lechner, Mudde, De Vries, & Bolman, 2010). Accurate health-related knowledge and understanding about self are important factors that prompt awareness of unhealthy behavior and barriers.

MEASURES OF AWARENESS IN PREVIOUS HEALTH BEHAVIOR RESEARCH

No single gold standard awareness scale is evident from previous literature of health behaviors. In fact, multiple types of awareness have been used and assessed to analyze the links between health awareness and the corresponding health behavior. Research on health-related awareness has been most observed in studies of disease prevention, PA, and nutrition, most often referring to perceived benefits/risks and personal behavior. Measurements of awareness mainly clustered in two categories: (a) investigation on the extent to which participants are aware of the knowledge about specific health outcomes and standards, and (b) evaluating the awareness level of one's own health behavior. The two categories will be thoroughly addressed in the following section.

Awareness of Knowledge

Mosca and colleagues (2006) conducted a national telephone survey using a standardized interviewer-assisted questionnaire to analyze the association between awareness of

cardiovascular disease (CVD) and preventive actions to lower risks among women. In addition to demographic and personal health information, participants' awareness was assessed through recent evaluation and knowledge of personal risk factors, general knowledge of healthy levels. Participants' preventive actions were also surveyed during the phone interview. The results indicated 55% of the participants were aware of CVD risks by answering that heart disease/attack is the leading cause of death, with a substantial gap between Whites and other ethnic groups. Similar results were reported regarding knowledge about healthy levels, indicating that the awareness of personal health levels was a significant predictor of preventive actions. Similar to Mosca and colleagues' study (2006), more research has indicated the importance of being knowledgeable of specific standards and being aware of personal lifestyle behaviors and health levels (Cheng et al., 2005; Nash et al., 2003; Ostchega et al., 2007; Petrella & Campbell, 2005).

In a cross-sectional survey study (Haase, Steptoe, Sallis, & Wardle, 2004), researchers investigated college student self-reported leisure time PA behavior in relation to their beliefs, awareness and other demographic factors in 23 countries. Specifically, awareness of the role of PA in heart disease was analyzed as a binary variable (i.e. aware or unaware), finding that 40-60% of the participants were aware of the relevancy between PA and heart disease. In general, awareness of PA benefits was found to be positively and strongly associated with economic development, while no significant differences were found between men and women. Furthermore, the logistic regression model indicated the awareness of benefits were not linked to leisure time PA behavior.

It is notable that PA awareness was generally measured in relation to existing PA guidelines, by asking whether participants have heard of such guidelines, as well as their

agreement with certain statements regarding specific PA recommendations. Bennett and colleagues (2009) examined the awareness of knowledge of national PA recommendation provided by CDC and ACSM among a probability-based sample of the US population using data from the Health Information National Trends Survey (HINTS) (Cantor, Covell, Davis, Park, & Rizzo, 2005). Participants were asked two questions regarding PA frequency and duration recommendations, with 57% and 86% correct rate, respectively, and only 33% were correct for both. In particular, those who met PA recommendations and those with highest educational levels were found to be more aware of the recommendations. Similarly, a recent Australian study (Berry, Nolan, & Dollman, 2016) measured awareness of PA guidelines. In the cross-sectional survey, only two questions were asked regarding PA awareness: (a) identify recommended daily PA minutes, and (b) whether PA needs to be vigorous to confer health benefit, which was answered on a Likert scale from strongly disagree to strongly agree. In general, 19.1% of participants were aware in both questions, with significantly stronger awareness among more women comparing to men.

Summary and Implication

Awareness has been used interchangeably with knowledge in many studies, representing an individual's knowledge about the consequences of certain health issues. Furthermore, unlike health knowledge that has been evaluated against standard answer keys, awareness has been usually evaluated as (a) a binary variable (i.e., yes or no), or (b) level of agreement with a list of statements and reported as proportions (Cheng et al., 2005; Eckel et al., 2009; Ferney Moorhead, Bauman, & Brown, 2008; Haase et al., 2004; Nash et al., 2003; Ostchega et al., 2007; Petrella & Campbell, 2005). Logistic regression has been used a lot to determine the associations between awareness and diverse variables, demonstrating contradictory results. Although numerous studies

implicated that awareness of nutrition knowledge as important predictor of dietary behavior (Nash et al., 2003; Neill et al., 2000; Ostchega et al., 2007; Stables et al., 2002), studies in PA demonstrated a weaker relationship between awareness and PA levels (Bennett et al., 2006; Berry et al., 2016; Haase et al., 2004). Overall results suggested limited awareness of national PA recommendation, concerning more effective intervention (Bellew, Bauman, & Brown, 2010; Bennett et al., 2009; Berry et al., 2016; Haase et al., 2004). Therefore, awareness of knowledge about PA benefits may not be as important as awareness of the recommended PA guidelines.

The accurate measurement of self-reported awareness is challenging because of the simplicity of binary variables in previous research (Cheng et al., 2005; Nash et al., 2003; Ostchega et al., 2007; Petrella & Campbell, 2005) while awareness is a more sophisticated process of an individual's perception of a complex status. Thus, more comprehensive assessment with acceptable validity and reliability may be informative to understand the value of awareness and its contribution to behavior changes.

Awareness of Self

Another critical component of awareness is the perception of self-evaluated behavior as a lack of awareness on one's own behavior may act as a barrier to behavior change, making it difficult for interventions to take effect (De Ridder & Lechner, 2004; van Sluijs et al., 2007; Weinstein, 1988). However, the majority of studies assessed self-reported PA as a measure of PA awareness. In particular, awareness of personal PA was usually assessed in a subjectively self-rated manner (De Ridder & Lechner, 2004; Lahart, Reichl, Metsios, Nevill, & Carmichael, 2014; Lechner et al., 2006; Ronda et al., 2001; van Sluijs et al., 2007).

Personal PA levels were examined in numerous studies as the major way to understand PA awareness, however, revealing that PA was oftentimes misperceived by people. Lechner and

colleagues (2006) studied misperception of personal PA, which was assessed in two ways representing subjectively and objectively self-reported PA: self-rated PA on a 5-point scale from very low to very high (De Ridder & Lechner, 2004), and a 14-item questionnaire (SQUASH) assessing health-enhancing PA based on PA guidelines (Wendel-Vos, Schuit, & Kromhout, 2003). The results indicated a very low level of agreement between two estimations (Cohen's Kappa = 0.29), observing nearly half of the participants who did not meet PA guidelines classified themselves as sufficiently active (Lechner et al., 2006), suggesting the overestimates of PA using self-reported methods. It is also noted that misperception of discrepancies between standards and personal health levels will lead to damaging beliefs that act as barriers to behavior change (Lechner et al., 2006). Similar findings were reported among adolescents and adults (Corder et al., 2011; Ferrari, Friedenreich, & Matthews, 2007).

A recent UK study (Lahart et al., 2014) assessed both awareness of PA levels and awareness of effects of PA on health, and examined the relationships between awareness and PA. Awareness of PA benefits was assessed using a questionnaire inquiring whether the participants believe PA's role in breast cancer is "increase risk", decreased risk", "had no effect", or "do not know". Awareness of PA level was assessed after notifying participants the amount of recommended daily PA, by asking them to respond to "whether they think they have enough PA". The International Physical Activity Questionnaire (IPAQ-LF) (Booth et al., 2003) was used to assess PA levels. The results indicated high level awareness of PA benefits on breast cancer (i.e. 75%), however, the majority of the participants inaccurately categorize their PA levels when comparing to their IPAQ scores. In addition, no significant association between awareness and PA behavior was found. As mentioned before, awareness of self needs to be based on accurate information. However, in the previous study, it was not clear if participants were aware of the

recommendation information as it was told before awareness assessment. Therefore, it is reasonable to doubt the accuracy of their self-rated awareness of PA levels, and the meaningfulness to associate the awareness with their self-reported behavior using the method of comparing the self-reported PA information with actually measured PA data against the recommended amount of PA.

Summary and Implication

Evidence suggested that poor awareness of one's own inadequate PA may result in less positive intention to manage their PA behavior (Lahart et al., 2014; Ronda et al., 2001; van Sluijs et al., 2007). Unfortunately, unlike other determinants of PA, awareness has not been a focus in previous research on this topic. In reviewing previous studies, awareness of personal PA was most commonly assessed by self-reported PA level. Participants did not accurately judge their own status with respective standards, which is an important process of awareness arousal.

It should be noted that PA is a complex health-related behavior consisting of a variety of activities scattering in daily life in different formats rather than running a treadmill or working out in a gym. Activities such as transportation, working, recreational activities are also included as daily PA, making it difficult for an individual to evaluate self-PA (Tudor-Locke & Myers, 2001), meanwhile, leading to the necessity of including awareness of environmental factors such as transportation, proximal facilities and potential opportunities for PA. On the other hand, given the complexity of personal PA behavior and environment, awareness of one's own level and surrounding facilitators may be considered to be a determinant of intention to change one's behavior (Goud, Pamidi, Devi, Nayal, & Kamath, 2014).

SUMMARY

Public understanding of PA awareness is suboptimal. Higher education has a unique opportunity, on the basis of physical education, access to fitness facilities and health services, to improve PA behavior and status among college students with extended impact. Although knowledge is considered one of the critical factors in establishing human behavior (Andrade et al., 1999), it is very unlikely to alter behavior without a sufficient level of awareness. Individuals with higher levels of PA knowledge and awareness are more likely to apply such knowledge to incorporate PA in their daily routine (Zhu et al., 1999). Unfortunately, PA knowledge among college students is not always correct and there are many misperceptions that they are not aware of (Keating et al., 2009). To date, literature supporting positive relationship between PA knowledge and behavior has been scarce, making the evidence inconsistent.

Although variation in methodology among studies might have contributed to the inconsistent findings of relationships between PA knowledge and behavior, we would suggest taking PA awareness into consideration when analyzing PA behavior, particularly PA. In spite of the controversial results, there were little data available regarding PA awareness and PA levels in college students. A valid and reliable instrument for assessing PA awareness in higher education settings is currently lacking. A study that incorporate PA awareness and PA behavior with valid and reliable instruments to evaluate the relationship would make an important contribution to the current body of literature.

Chapter 3: Understanding College Student PA Awareness -- Study I

RESEARCH AIMS AND QUESTIONS

The purpose of this study was to understand how college students make sense of PA as part of their daily experiences and to identify the domains of PA awareness. The study addressed construct definition and content domain. By comparing the domains of awareness developed from the collected data to an existing theoretical framework (Marton & Booth, 1997), a modified version of structure of PA awareness was proposed, which constituted the basis for study II, focusing on the instrument development that could be used to measure college students' PA awareness. Two research questions were answered:

1. How do college students understand their own PA behaviors and PA-related factors in the college setting?
2. What are the domains of college students' PA awareness?

According to Corbin and Strauss (2008) qualitative research is particularly useful when little is known and explored about a topic. It produces more in-depth, comprehensive information with holistic contextual description of how people experience selected research issues. One advantage of using qualitative methods in this exploratory part of this research is that the open-ended questions and probing allow participants to provide rich, meaningful and culturally salient responses in their own words. Another advantage is the flexibility of researchers to probe initial responses by asking "why" and "how" (Mack et al., 2005). This requires the researcher to be a careful listener and an engaging facilitator who encourages participants to elaborate on their answers. Qualitative methodology has recently become more common in physical education research as it is suggested to have the potential to inform best practice in the field (Hemphill, Richards, Templin, & Blankenship, 2012).

THEORETICAL FRAMEWORK

Phenomenography

Qualitative researchers usually explore an issue by means of describing a behavior, understanding an idea or explaining a phenomenon. Depending on the researcher's purpose, different theoretical frameworks should be followed to guide the qualitative research. This study will take a phenomenographical approach to explore college students' conception and experience about PA awareness. Developed by Marton (1986), phenomenography explores how people experience, conceptualize, realize and understand phenomena around them in a variety of ways. The researcher cannot observe what a college student thinks about PA and how awareness is generated, therefore phenomenography provides the researcher a second order perspective to understand the student's experience of awareness construction, which differs from phenomenology's first order perspective of understanding the phenomenon. In addition, phenomenography allows the researcher to identify not a singular essence, but the multiple conceptions in various aspects of a particular phenomenon, which is distinguished from phenomenology (i.e. focus on individual experience). Phenomenography identifies the essence of human experience about a phenomenon described by the participants, rather than the phenomenon per se (Marton, 1986). In other words, it is not about the researcher's awareness and reflection but the awareness and reflection of the subjects (Orgill, 2012), which requires the researcher to prevent imposing a rigid set of pre-existing perspectives and analyze the data with an open mind (Mertens, 2010). It is important to note that phenomenography provides ontological assumptions: (a) the experience depends on the context or environment where it takes place, and the reality outside; (b) the phenomenon and the conception of the phenomenon are related (Svensson, 1977; Tsai, Tsai, & Hwang, 2011; Yates et al., 2012).

The reasons for using phenomenograhy in educational research are as follows. First, it probes how students develop multiple, different and alternative conceptions for a phenomenon that may not be consistent with experts' conceptions (Åkerlind, 2012; Entwistle, 1997). Second, it is possible that students may become aware of and open to alternative or contradictory opinions as they reflect on their own conceptions of the experience (Åkerlind, 2012; Marton, 1997). Finally, the information may help educators design better curriculum or teaching strategies that meet students' needs through understanding their ways of constructing knowledge on a certain subject (Bruce & Hughes, 2010; Ornek, 2008).

RESEARCH DESIGN

This study took a focus group approach with a moderator asking a set of pre-determined questions targeting at understanding college students' perceptions and awareness of PA. Traditionally, focus group discussion involves engaging a small number of people in an informal group discussion on a particular topic or set of issues to gather data from multiple individuals (Wilkinson, 2004). Focus groups create a sense of belonging to a group that increases participants' sense of cohesiveness (Peters, 1993), therefore, provides a more comfortable and safer environment for participants to share ideas and thoughts (Krueger & Casey, 2000). Especially in social science research, the interactions among participants may trigger spontaneous responses, which are good sources of important information (Butler, 1996; Morgan, 1997). As suggested by Lunt (1996), data from focus group method may be used to identify salient dimensions of complex concepts for further quantitative study.

Participants and Settings

Krueger (2000) and Morgan (1997) have suggested that 3 to 5 different focus groups are adequate to reach data saturation (i.e., information occurs so repeatedly and the collection of more data does not provide any additional interpretive worth) (Sandelowski, 2008; Saumure & Given, 2008) or theoretical saturation (i.e. the researcher can assume that the emergent theory is adequately developed to fit any future data collected) (Sandelowski, 2008), with each group meeting once or multiple times. Focus groups can be preexisting groups (e.g., classes, work groups), newly formed groups constructed by the researcher's random selection or, more commonly, any purposive sampling techniques (e.g., homogeneous sampling, maximum variation sampling, critical case sampling, or multistage purposeful sampling (Onwuegbuzie & Collins, 2007).

For the purpose of this study, purposive sampling was used to select information-rich cases that would collect data and shed light on the phenomena of interest. In particular, network sampling was used for participant recruitment. The researcher contacted university professors to ask permission for potential recruitment in their undergraduate classes. Upon specific explanation of the study, one professor permitted the researcher to conduct the interview in class. Overall, five focus groups were recruited from the five sessions of an existing undergraduate class at a four-year university. The researcher was permitted to conduct the interview during the in-class discussion for 45 minutes. The group size was around 15 for each session. The researcher created pseudonyms (i.e. letters) to protect the confidentiality of all participants.

Data Collection

The interview took place in the regular classroom where the class usually met for their discussion. All interviews took place on the same day, at different times due to the class schedule. A moderator is a key element for conducting a focus group discussion (Krueger, 2000). The researcher served as a moderator to facilitate the discussion by prompting participants to speak, encouraging sharing of opinions, and ensuring equal participation within the group. The moderator made it clear that the discussion should be open and all participants were allowed to think aloud and be doubtful. The moderator did not evaluate the answers as being "right" or "wrong". Furthermore, the moderator was responsible for taking notes that informed potential questions to ask.

All conversations were recorded and stored in a digital database. Recorded focus group interviews were then transcribed verbatim and placed in word processing files for later integration and interpretation. In addition, each participant was assigned a name tag with a letter on it during the interview. The letter was used for taking notes, in order to identify the speaker without knowing their personal information in the audio recorder. The informed consent form (Appendix A) was signed by the participants prior to the interview.

The Interview Questions

A pre-interview survey (Appendix B) was distributed to collect basic background information from the interviewees (i.e. major, class standing, living status, transportation, working status, overall health, exercise habits, experiences in PE/fitness classes, previous participation in organized sport if any, etc.). The focus groups were led by the researcher who served as the moderator using a semi-structured guideline that included the following questions.

1. How much do you know about PA and your own PA?
2. What makes you think that you know your own PA well or unknown?
3. What do you know about PA recommendations/guidelines?
4. What resources (i.e. persons, campus services, organizations, policies) do you get information to participate in PA or PA-related events?
5. What do you find to be difficult about getting information related to PA or PA related events?
6. What did your university do (or not do) to increase your PA awareness?

Data Analysis

Source of Data

Focus group data includes three types: individual data, group data and group interaction data (Duggleby, 2005). While most researchers use group data as the unit of analysis, there has been an argument as to the most appropriate unit of data to analyze among focus group theorists (Kidd & Marshall, 2000; Morgan, 1997; Wilkinson, 2004). In particular, most researchers use group data as the unit of analysis, in which case, little information is collected from participants who are relatively silent, less articulate, or have marginalized opinions, and only the emerging themes are interpreted, failing to explain the degree of consensus and dissent (Wilkinson, 1998). It is suggested by other researchers to not only present emerging themes but also interpret argumentative interactions (Kitzinger, 1994) to increase the validity, variety and richness of the data (Maxwell, 2005).

Analytic Framework

A number of phenomenographic studies have applied a structure of awareness as a framework to analyze data and describe experience of a phenomenon (Booth & Ingerman, 2002; Cope, 2002; Marton & Booth, 1997). Based on the field of consciousness (Gurwitsch, 1964), awareness is made up of three overlapping aspects. The theme, which is known as the internal horizon, includes the aspects of the phenomenon as well as the links between the aspects. The external horizon that consists of the thematic field and the margin, refers to the context in which the themes sit. As part of the external horizon, the thematic field is directly related to the theme, and consists of structural aspects that are simultaneously and collectively present in awareness; while the margin refers to aspects of the world that are not directly related to the theme (Marton & Booth, 1997).

Analytic Procedure

The process of phenomenographic data analysis is iterative and comparative, which involves continual sorting of emerging perceptions from the data into "categories of description", (i.e. "outcome space") and ongoing comparisons between the data and categories, as well as between the categories (Åkerlind, 2005; Marton, 1986). A three-step process was used to analyze the transcripts. First, transcripts will be read as a whole to identify all relevant codes. Both open codes and codes from existing theoretical concepts were used. Second, a constant comparative analysis was used to assign concepts into categories or structures. Throughout the second step links among categories were investigated. Finally, the last step in the analysis was to identify internal relations among categories to construct an outcome space that delineated the structure of PA awareness.

Researcher's Experience and Positionality

In conducting qualitative research, it is important to remember that the researcher is the primary instrument for data collection and analysis (Marshall & Rossman, 2011). The researcher must possess comprehensive knowledge of the subject matter and intricate inquiry skills to navigate each step of the process when collecting and analyzing the data. As a doctoral student in physical education and graduate teaching assistant in two conceptual fitness classes, I had sufficient content knowledge in PA and the unique experience of working with college students to understand the current discourse regarding PA among college students. These experiences provided me with first-hand knowledge about college students' concerns and perspectives on the topic of the present study. As a physically active individual myself, I pay special attention to my personal PA in terms of tracking my weekly participation and identifying available resources in my surroundings to optimize my PA experience. Such experience, though important, could also be a source of bias. I wanted to understand how college students describe their own PA experience and how they perceive the impact of surrounding factors on their experience. Because of the inherently interpretive nature in qualitative research, the researcher's thoughts and beliefs might influence every single step of the research process. As such, it is important for a qualitative researcher to keep critically examining and reflecting on self to minimize the influence of personal subjectivities on the study. Specific steps were taken to ensure the trustworthiness and credibility of the data collected.

Trustworthiness and Credibility

In qualitative research, trustworthiness has been described as critical as validity and reliability in quantitative research (Marshall & Rossman, 2011). A number of strategies were used to ensure the trustworthiness of qualitative data and reduce the likelihood of researcher's subjectivities influencing the interpretation. First, peer debriefing was utilized as a main strategy to ensure the rigor of the analytic process. In this study, a university peer (i.e. knowledgeable doctoral student) was invited to review coding and emerging themes (Marshall & Rossman,

2011). The technique of inter-judge reliability is mostly used for reliability check in phenomenography, with an agreement rate of 80% to be acceptable (Dahlin & Regmin, 1997; Säljö, 1988; Tsai, 2004). Therefore, the agreement rate of 90% between two independent reviewers in this study ensured the reliability of the qualitative data. Second, due to the phenomenographical nature of the study, in which the aim is to understand the variation in conceptions expressed by participants, negative case analysis was infused throughout the analytic process and peer debriefing process to help the researcher identify disconfirming data. Third, audit trial was a strategy suggested to document the entire research process including data collection procedure, analytic process, and key steps or decisions that lead to the shift of focus of the researcher (Marshall & Rossman, 2011). Audit trial takes the form of a research log, for instance, recording dates, times, locations and contexts for each focus group discussion to allow track of the evolution of key findings and to confirm sufficient agreement between actual research steps and the original plan (Mertens, 2010).

Participant Profile

In order to better understand participants' perceptions, the brief background information and PA-related lifestyle was collected. A total number of 40 students participated in the interview (i.e. $N_1 = 9$, $N_2 = 9$, $N_3 = 8$, $N_4 = 13$, and $N_5 = 11$). The number of male and female participant were about even (i.e. 21 males and 19 females). The majority were Caucasians (N = 29), and freshmen (N = 29). Walking was the major transportation the participants used to commute to campus (N = 35). All students indicated they exercised at least 1-2 times per week, except three of them indicated they had never exercised. Only 4 students had taken PE credits in the university even though they were not in kinesiology-related major.

RESULTS

Several themes emerged as the major findings of the study. Because the interview questions were pre-determined to have a combined interpretation of college students' PA awareness, results of a single interview question may only reflect some aspects of the question or interest, it was decided to report the findings by themes. Therefore, results of this study were organized in the sequence of the analytic framework (i.e. internal and external horizons) to understand PA awareness. The internal horizons of PA depicted college students' perceptions and experiences of PA in terms of perceived benefits, personal motivators and barriers. The external horizons focused on students' perceptions of social interactions and environments where PA took place to illustrate the underlying sources of their PA awareness. It should be noted that the results of self-evaluation as an internal aspect was combined with PA recommendations as an external aspect in the end, because of the interconnection between these two concepts.

Internal Horizon: Students' Perceptions of PA

Throughout the focus group interviews, students described PA as activities that require extra effort than daily routines that usually brought their heart rate up, and benefited their mental and physical health. In addition, they were likely to associate PA with calorie burns and weight loss. While they understood that PA took various forms in life, "exercise" or "work out in the gym" seemed to be the major terms they referred to when asked to give specific examples of PA. It was interesting to find out about the different opinions they held towards walking as a particular type of PA, as some of them indicated they took walking as an alternative to exercising,

> I know walking to and from class can be considered a workout. (L in group 1)
> I'm getting more of walking, so I don't feel too bad when I never exercised. I do a lot of walking pretty much every day, so it's kind of exercise. (C in group 1)

> My favorite physical activity is just walking around campus and back home. (B in group 2)
> I will always park at the top of the parking garage and never take the elevator. (K in group 3)
> You burn a lot of calories walking. (Q in group 4)
> I don't think it's necessary going to the gym…something that's like you're moving around. (C in group 5)

While others thought walking was not intense enough to get their heart rate up or lead to desired health benefits, therefore, did not necessarily count as PA,

> Not something you have to do when...like walking to class. (F in group 1)
> I think walking is not the best if you're looking to lose weight, burn calories and get more exercise. (M in group 4)
> I view physical activity more as going to the gym or stay in sport, more than just walking to class. (N in group 5)

Internal Horizon: Students' Experiences of PA

In general, the participants had relatively positive personal experiences with PA engagement, because they felt healthier and less stressed when they were physically active, which might also lead to better performance in other various life aspects.

> A variety of physical activity that I enjoy it, occasional work-out. So as not too serious to have some fun. (O in group 1)
> I mostly do yoga because it keeps my muscles stretched out and relaxed I spend a lot of time in one position and so yoga for me is a way to get out of that position. It keeps me healthy enough with life. If I don't do it, I get tendinitis or tennis elbow and stuff like that. But I also go running because it gets my heart rate up and definitely helps with blood flow and keeping my mind clear. (Q in group 1)
> In addition to that it's just to stay fit. The more general term it's more for me just to relieve stress, because my major is very stressful, and you need that kind of outlet to get your frustration out. (J in group 2)
> It improves your quality of life…it affects not only your sleep and your heart rate and your blood pressure, it affects every aspect of your life. (N in group 3).
> I feel like it's like a release for a lot of college students to get their mind off a thing. It's like that one time where you're not on your phone, you can't do anything else you're just engaged in what you're doing and getting more active and healthier. (E in group 4)
> It helps make friends, because when we're doing sports we're relaxed and nothing about stress just enjoy ourselves. Also it helps me sleep, because when I get exhausted I just want to go to bed early. (N in group 4)

While the PA experience was fun and enjoyable for those who had better self-efficacy and were more engaged in sports, it could be a little intimidating for those who were less skilled, therefore, had confidence barriers. Moreover, such confidence barriers affected their self-perceptions in an open PA environment, such as in the gym, group activities, or exercise classes,

> I think it's better to understand how to use the equipment, especially someone who would be considered very entry level at the gym, everyone in there's like, "mm-mm", and I'm usually on the treadmill and-[laughter] I prefer to work out in solitude, to just kind of avoid that intimidation back here. (C in group 1).
> That is a huge confidence barrier a lot of people have to overcome when it comes to going to the gym and actually using the equipment there, because they're always pinching themselves, like, "Oh man, how are other people going to look at me if I'm sweating my ass off on this treadmill or I'm using this equipment wrong?" (J in group 2)

In addition, a lot of them agreed that PA was something to be incorporated into daily life.

> That's just my personal thing. (O in group 1).
> I park far away in a parking lot, I try and make just kind of generally my day filled with physical activity. Spending an hour cleaning the house and doing laundry is a lot of physical activity. I just build it into my daily life. (K in group 3)
> I think it's like a lifestyle for me to try to be physically active. (J in group 4)

External Horizon: Social Influences on Students' PA Experience

Many students indicated that their PA behavior were influenced through social interactions with family, friends and peers. They became motivated in PA for better health and maintaining social relationships.

> A couple of years ago I had an uncle who died at 43, he had a heart attack. That was like, "Wow, I don't want that to happen to be me", so I should probably start working out sometime soon. That is by the farthest the thing that would motivate me to work out. (C in group 1)
> Sometimes, every night we go running**,** "Oh, yes, we're running tonight." It's a big nightmare but it's also a motivator like on my calendar, and monitored, just because I know it's good for me and it's something we can do together. (Q in group 1)
> I feel like the way I became more aware of physical activity is through-- a lot of the people in my dorm are very active so just the interaction with them. Going to

> the gym with them and whatnot. That's where I got the information for physical activity. (O in group 2)
> The way I got motivated is this kind of mindset of "You're not good enough, so get better" placed there by the coaches. (N in group 3)
> I like the social aspect of going to the gym. It's about connecting socially with me. I'd like doing Zumba classes, and I still go, because it's fun. It's play, it's not competitive, and it's movement with other people. (K in group 3)
> I have a lot of friends who are really active and I've made a lot of friends here who are also really active in sophomore. They are always working out and that's their hang out, so it's motivated me. Having friends that are really into it keeps me motivated and helps me. (H in group 4)
> I feel like it's important to learn from other people and how they're doing. (P in group 4)
> It motivates other students to get involved because so many current students are involved almost like a crowd effect. (K in group 5)

Interestingly, a number of students mentioned the negative impact of social interaction on their PA. In those cases, the lack of confidence played a discouraging role, especially in a socially comparative setting,

> Judgment is a big part of it. You're graded when you work out, so it's like there are some kind of expectations. You're afraid of being average or for being average sometimes and discourage people from competing in the gym. Seeing other people who are way ahead of the progress level because they've been working out for many years but they haven't. For me, I'm below them obviously. That started to discourage for a lot of people. (N in group 1)
> That is a huge confidence barrier a lot of people have to overcome… because they're always pinching themselves, like, "Oh man, how are other people going to look at me if I'm sweating my ass off on this treadmill or I'm using this equipment wrong?" (J in group 2)
> Doing something new is just intimidating in general, but then, if someone said, "that's the environment you're in." It depends on thinking, what it is or who you're surrounded by. (G in group 4)

External Horizon: Environmental Influences on Students' PA Experience

In addition to their social relationships, college students indicated that they planned their PA based upon the conditions of PA facilities in their living environment, which in this case, the indoor gyms and outdoor space on campus or near their residence hall. In general, limited space and equipment created a competitive atmosphere that not only lessened students' exercise

efficiencies and satisfactions, but also brought aforementioned social pressure to those who were intimidated by superior performers.

> I looked at when the gym is really busy so I don't go at those certain times that I used to go more often…they should build a better gym here…more space and different equipment, because they have a limited amount of equipment. I force myself to go. (P in group 2)
> Yes, because you don't want to play tennis when it's really hot outside, you want to play when it's not, decent enough, and so not having good lights, or good courts, deters you from wanting to play. (A in group 3)
> I'd say they need more gyms or a bigger gym or something because Gregory is always crowded. (F in group 5)

Nevertheless, a good number of students suggested that having access to PA facilities (i.e., gyms and outdoor fields, etc.) and PA-related organizations (i.e. sports clubs and exercise classes, etc.) helped lessen the barriers and therefore, motivated their PA participation.

> I guess yes, club activity does raise my awareness of physical activity. (O in group 1)
> It seems like physical activity is really centered around indoor resources. It'd be cool if maybe outdoor resources were encouraged more and regulated more. Paths, trails, I don't know. (B in group 2)
> My dorm has a really nice gym in it, and so, it's easy access so that makes me want to work out more and I always see people going to the gym, and that makes me want to do it, too. (E in group 3)
> In my experience it's pretty easy to get in a contact of people who are in the club and then you can just go from there. It's pretty easy to-- it's not intimidating try to join something- or something fitness-related. (P in group 4)

Interaction: Self-evaluation and the PA Recommendations

It is also important to understand how college students evaluate their PA levels and reflect on their PA behaviors, and how their PA behaviors might have been influenced by their self-evaluation or the PA recommendations. When asked whether they were regularly keeping track of their own PA levels, most participants indicated they did not intentionally or objectively assess their PA levels.

On the other hand, a few participants did indicate that they tracked their own PA levels during activities, however, the methods they used varied by activities,

> I rather than seeing how much physical activity I can do, I noticed that I have a lot of physical activity and I realized, "Wait, I haven't really done anything in weeks, I should probably go for a run or I should go play soccer." (G in group 2)
> For me I keep track of what I do and I'll change it up with each week. (F in group 4)
> When I run on the treadmill, I monitor the calories, the distance or time. (G in group 5)
> When I'm climbing, I really care about how fast I am. (Q in group 5)
> Not necessarily time, but maybe once you're playing basketball where you've played three games, and after three games it's like "Oh I played for an hour or something." (C in group 5)

Meanwhile, rather than assessing PA levels, college students were more likely to pay attention to their physical appearances (i.e. weight, body shape) or fitness-related indices (i.e. body fat, breath and post-activity exhaustion) as the indicators of their PA needs. Specifically, students became aware of the need to increase PA when they were confronted with health deficiencies or undesirable body changes,

> I guess what makes me aware of my physical activity level, or I should say lack of it, is whenever I go 21st street and I get to the top and I'm super out of breath. (C in group 1)
> My cardio shouldn't be this god-awful. I should not be getting out of breath just biking up the 24th street hill...it told me, okay you need to go (do) some more cardio. (J in group 2)
> I try to keep track of my weight, my body fat percentage to just monitor progress. (N in group 3)
> Whenever I walk up a flight of stairs, if I feel tired afterwards I'm like, Ahh, I got to run more. (B in group 3)
> If I feel like I'm gaining weight or something it definitely motivates me to go to the gym and to get in a routine that will last, until I'm feeling better. (I in group 4)
> For girls, I think the conversation about physical appearance is a pretty big one, so I think a lot of times when girls feel like they're not thinning up or toning it up, that's what really leads to them going to the gym, not necessarily just being healthy. (A in group 4)
> It's like every single guy is trying to get bigger. (M in group 4)

Given that PA levels were seldom self-evaluated by college students, it was not surprising to find little or no understanding of the PA recommendations. When being asked how much they knew about what PA recommendations, their attitudes towards PA recommendations were negative, and described the PA recommendations as standardized/normalized numbers that might not necessarily apply to everyone,

> I feel like everyone's body type is different, so it depends. Like 30 minutes doing some jogging might be not as effective as who is really fit. You need to do like an hour instead. (D in group 4)
> Obviously, there's probably a baseline for healthiness, but I don't think that that's necessarily a good thing to strive for or even look at. (P in group 4)

Moreover, after the PA recommendations were briefly explained by the interviewer, students had different opinions on how the recommendations would impact their behavioral change. Some of them agreed that knowing the PA recommendations was helpful and might motivate them to be more active if they knew they were below the recommended levels;

> But people are not as active as they should be...that they should be more active. I think guidelines are helpful if you don't already know like what you should be doing. (L in group 1)
> I think it would give you what's expected, might impact some people… (if you're below the standards), it's a motivation. (K in group 3)
> I think having a guideline is really helpful, especially when I have an appointment that I can do each week, it's very helpful. (Q in group 4)

Meanwhile, others indicated knowing the PA recommendations would not make a difference to their PA behavior, especially when they were already achieving or above the recommended PA levels,

> Probably because I know I'm way above the level anyways like that the guidelines, so it doesn't...knowing it doesn't really make a difference. (J in group 1)
> My cardio shouldn't be this god-awful. I should not be getting out of breath just biking up the 24th street hill...it told me, okay you need to go (do) some more cardio. (J in group 2)

Interestingly, contradictory opinions emerged as some students stated that having intense standards might not motivate them to participate in more PA, instead, it could be discouraging for those below the standards (recommendations).

> It was actually pretty discouraging instead of encouraging to get up on it, instead you gave up on it. (M in group 3)
> I feel like those standards are always really good but they are also set very high to be like perfectly healthy...it's just difficult. (K in group 5)
> If you were like way below standards, and you're probably doing well, and you found out that you were doing terribly. I feel like that would be pretty demoralizing. (F in group 5)

DISCUSSION

Research indicated that knowledge and behavior relevant to PA are at risk of being suboptimal among college students (ACHA-NCHA-II, 2010; Keating et al., 2009). Further examination of this phenomenon is needed to elucidate how college students understand PA as it relates to themselves as well as the outside world. This study attempted to capture various PA experiences among college students, for the purpose of identifying key constructs of awareness that may contribute to the changes of their PA behavior. By examining the internal relationships among each construct, the two research questions were answered, and college students' PA awareness was delineated. The main finding of this study indicated that students have deficient knowledge to integrate PA in the college setting, regardless of their willingness to improve. College students should be aware of the weakness by paying close attention to their own PA and the environment to characterize efficient approach to PA improvement.

Research Question 1: How do college students understand their own PA Behaviors and PA-related factors in the college setting?

The first question pertained to how college students understand their own PA behaviors as well as PA-related factors in the college setting. It is encouraging to find that college students had the basic understanding about PA in general (i.e. what is PA and why is PA important). However, most of them lacked the essential knowledge regarding how to incorporate PA into

daily life even though they had the tendency to do so. Moreover, students put little values on PA recommendations and accurate PA assessment, therefore, were less likely to self-monitor their own PA levels using objective measures. In addition, the interactions of personal, social and environmental factors played compound effects on college students' PA behavior.

The Lack of Knowledge Specific to PA Recommendation

As most participants in this study indicated they became aware of the fact that PA was important in maintaining health and it needed improvement, there were quite a number of them who did not have individualized action knowledge (Cao, Schüz, Xie, & Lippke, 2013; Conner et al., 2010; Li et al., 2016) on how to incorporate PA into college life, where priority is given to academics. Although it was encouraging to find out the prevalence of positive attitudes towards PA, the challenges still exist. College students have been faced with an intractable paradox (i.e. high recognitions of PA benefits vs. weak actions to get the benefits) for decades (Keating et al., 2010; Knox et al., 2012; Maddock et al., 2003; Ward, 2014).

There may be several reasons contributing to the absence of knowledge that were critical to PA improvement among college students. First, it might be the results of ineffective K-12 PE they received prior to college. The low prevalence of PA knowledge among pre-college adolescents has been reported in previous research (Keating et al., 2009; Thompson & Hannon, 2012; Williams, et al., 2013), indicating the limited success of K-12 PE programs for preparing physically literate individuals. The role of prior knowledge was suggested to be positive in that it could reduce the decline of the interest in PA knowledge in later years, which may subsequently contribute to PA participation (Zhang et al., 2016). Furthermore, knowledge taught in PE mainly focused on nutrition, PA benefits and physiology, with partial articulation on how to incorporate PA by multiple means (Chen & Nam, 2017; Lanigan, 2011). Specifically, in this study, the

majority of the participants were from a state that only mandates one year of PE in high school, thus, had minimal exposure to PA knowledge and PA opportunities as part of the PE content. Second, despite their recognition of various forms of PA, students were more likely to associate PA with exercise or work out in the gym, which were seemly "boring" and "time-consuming", therefore less attractive. Given that "time" was claimed to be their greatest barrier for PA, it is reasonable to conclude that college students need to be more aware of the miscellaneous opportunities around campus to integrate PA throughout the day rather than planning a 2-hour trip to the gym. In order to maintain a physically active lifestyle that could be extended to later adulthood, college students need to have the capabilities of making healthy choices by effectively adopting various forms of PA into their daily life. Such capabilities need to be cultivated throughout the course of their college years. Third, inaccurate information from unauthorized sources (e.g. media or internet) may have also contributed to the misconception of PA among adolescents and young adults, without the benefit of PE in high school and college. Students in this study illustrated the difficulties they encountered in attempt to improve PA knowledge by searching for relevant information on the internet. The overwhelmingly vast amount of information was made available due to rapid development of technology-based communication, which may lead to inaccurate conception, subsequently a barrier to desirable behavior change (van Sluijs et al., 2007). In addition, the lack of required PE in high school may leave a gap in building their capacities to verify the authenticity of information relevant to PA.

Although PA recommendations by the WHO provided the basic guidelines of different types of PA for health enhancement, knowledge of the guidelines were not prevalent among college students. More unexpectedly, these guidelines were questioned by the students regarding their applicability to the diverse population. It was promising that students were aware of

individual diversities when it came to PA participation. However, their doubts of usefulness of the PA recommendation by WHO were primarily from their personal concerns, rather than reliable sources of knowledge. This is problematic for PA promotion because those who were not aware of PA recommendations had a skewed view of their own behaviors and were consequently not achieving recommended PA levels (Ronda et al., 2001).

The Lack of Self-assessment

As mentioned earlier, PA knowledge is as important as PA behavior in maintaining an individual's health (Adams et al., 2006; Heinrich et al., 2011; Keating et al., 2009). The knowledge should include not only PA benefits or scientific principles in general, but also individually relevant information that could be used for personal improvement (Zhang et al., 2016). A physical literate college student should be able to accurately evaluate one's self behavior as well as identify key factors from the outside world that may either hinder or facilitate their desired behavioral change (Zarcadoolas et al., 2006). Without recognizing an individual's unhealthy behavior (i.e. PA deficiency), healthy behavior change (i.e. increasing PA) could not take place (van Stralen, Lechner, Mudde, De Vries, & Bolman, 2010).

In this study, objective PA assessment was seldom used among college students as those who maintained physically active believed that they had achieved sufficient amount of PA based on their reflection. Previous studies suggested that PA levels were oftentimes overestimated by individuals, resulting in weaker intention to initiate positive changes (Corder et al., 2011; Friedenreich & Matthews, 2007; Lahar et al., 2014). As a complex behavior, PA scatters throughout students' daily life in a variety of forms that are not limited to running on a treadmill or weight lifting, making it challenging to accurately self-estimate. For college students, a considerable amount of their PA lies in their daily routines such as transportation, working, and

recreational activities, which they may not recognize as PA and fail to assess. On the other hand, students who lived a sedentary lifestyle did not see the necessity of assessing PA. Instead, knowing the gap between their own PA levels and the expected PA levels was discouraging, and not helpful to motivate behavior change. This finding also confirmed another decision-making choice (i.e. escape) in the self-evaluation process as a response to a large discrepancy (Morin, 2003).

The absence of PA self-monitoring calls for attention. The use of objective measuring tools allows for an individual to monitor PA levels under free living conditions throughout one's daily life (Normand, 2008). With a variety of PA products available in the market, students had multiple options to monitor their own PA behavior. However, the result found by the study were disappointing. Self-monitoring has been shown to be an effective behavioral strategy for PA improvement, especially when used along with the implementation of goal-setting (Normand, 2008; Wack et al., 2014). In a study that examined effects of different intervention components on PA, Normand (2008) concluded that self-monitoring was effective in brining attention to daily PA. According to the SAT (Duval & Wicklund, 1972), accurate information regarding both PA recommendation and self-evaluated PA are critical elements to raise awareness and further trigger behavior change. Nevertheless, the concept of "PA self-assessment" was commonly absent among college students, along with the neglect of PA recommendations, preventing them from meaningful thinking for potential behavior change (Corder et al., 2011; Friedenreich & Matthews, 2007; Lahar et al., 2014). It is possible that the low prevalence of PA self-assessment was associated with the lack of PA recommendation knowledge among college students. The importance of the "goal" on changing PA behaviors has been illustrated in a number of studies (Burns, Brusseau, & Fu, 2017; McEwan et al., 2016; Tremblay et al., 2011). Meanwhile self-

monitoring is an essential component of goal setting process as it provides evidence for goal achievement (Normand, 2008). Not knowing the PA recommendation creates a gap for PA goal, without which, self-assessment becomes seemingly unnecessary or meaningless.

The Interplay of Individual, Social and Environmental Factors

Consistent with previous studies, the findings of this study confirmed that social and environmental factors each had great impact on a student's PA behavior (Barfield & Hutchinson, 2012; Belanger & Patrick, 2018; Farren, Zhang, Martin, & Thomas, 2015; Pauline, 2013, Zick, Smith, Brown, Fan, & Kowaleski-Jones, 2007). Specifically, social influences from friends and peers were seemly more powerful than family members. Transitioning from a high school environment to a college environment involves changes and challenges that affect their behavior (Deforche, van Dyck, Deliens, & De, 2015; Pauline, 2013). With perceived time constraints, priority is placed to academic activities, impeding students' motivation to be physically active (Deforche et al., 2015). In attempting to promote PA in college, a lot of intervention studies have been conducted, with unsustainable effects (George et al., 2012). Meanwhile, social influence has been well documented to shape college students' PA behavior (Barfield & Hutchinson, 2012; Belanger & Patrick, 2018; Farren et al., 2015; Pauline, 2013; Zick et al., 2007). Comparable results were found in previous research that for college students, friends had more motivating power with respect to weight loss or exercise (Okun, Karoly, & Lutz, 2002; Prochaska, Rodgers, & Sallis, 2002). Typically, college students live in a context that is close to an immediate social group with friends and peers, therefore, are more likely to be influenced by them rather than family members (Belanger & Patrick, 2018; Gruber, 2008; Pugliese & Okun, 2014).

Moreover, college as a setting where PA can be excessively observed, could be an ideal environment for PA retention (Farren et al., 2015). The results are consistent with previous

studies in that students recognized the advantage of being in a college campus where they were offered spacious structure and design for walking, indoor and outdoor exercise facilities for workout and sports, PA courses for skill acquisition, as well as resources such as sports clubs and fitness centers (Bopp, Kaczynski, & Wittman, 2011; Roemmich, Balantekin, & Beeler, 2014). Students should become more aware and make the best use of their campus environment and identify more PA opportunities that could be integrated into their daily routine.

Gender difference. Some studies reported gender differences regarding how social norms affect PA behavior, suggesting the psychosocial factors that motivates male students were competition, affiliation and social recognition, whereas female students were more driven by perceived appearance, health and stress management (Paulin, 2013). However, results in this study did not reveal such differences, indicating both genders perceived a similar span of aforementioned psychosocial factors. This may be partially due to the different research methods applied (i.e. qualitative method in the present study vs. quantitative method in previous studies). More importantly, the finding of more shared psychosocial factors of PA between male and female students in this study might be an indicator that future PA-promotion initiatives need to take a more complex net of factors into consideration to better accommodate students' psychosocial needs.

Furthermore, the results confirmed previous findings that female students perceived more social influence in a group setting of aerobic activities, whereas male students were more aware of their social environment during muscle-strengthening activities exercises (Carlson, Fulton, Schoenborn, & Loustalot, 2010; Carsper, Harrolle, & Kelley, 2013; Salvatore & Marecek, 2010). Other research suggested that female college students' PA behavior were more likely to be influenced by their friends and peers; male students, on the other hand, were perceived to be less

open to social influence and received less advice to avoid controversy (Gruber, 2008). Again, such gender differences were not found in this study. In contrast, male students in this study were more aware of the influence from the friends and peers that positively influenced their PA behavior than their female counterparts. Additionally, male students were more aware of the constraints (i.e. limited space, insufficient amount of equipment, and competition etc.) in their preferred physical environment, which discouraged their PA participation. Specifically, the lack of knowledge and competence to use the equipment in a weight room emerged to be their major concern.

Social-ecological model. According to the social ecological model, behavior is a dynamic process involving simultaneous influences from all levels of aspects within the framework (Stokols, 1992). It acknowledges the impact of personal attributes (e.g. self-efficacy), social environment, and physical environment on PA change (McNeill, Wyrwich, Brownson, Clark, & Kreuter, 2006). Results from this study confirmed the interplay of multiple levels of factors (i.e. personal, social, and environmental) on PA, varied by perceived self-efficacy. Comparable results were reported by McNeill and colleagues (2006), that individual-level factors mediated the indirect effects of social and physical environmental factors. In their study, it was also found that physical environmental factors directly affected PA, which confirmed the appropriateness of including the investigation of the physical environment on campus in this current study as an attempt to understand college students' PA awareness (Owen, Humpel, Leslie, Bauman, & Sallis, 2004).

Additionally, the current study upheld the conclusion in previous studies that the environment may provide various opportunities and barriers to PA engagement (Biddle, Atkin, Cavill, & Foster, 2011; Sallis, Floyd, Rodriguez, & Saelens, 2012). Specifically, environmental

effects may differ based on different types of PA, as reported in a study by Li and colleagues (2016) that examined individual, social, and environmental influences on PA in first-year college students. In regard to particular PA types, the role of environment factors varied. It was suggested that students with intrinsic motivations were more aware of the opportunities in their physical environment where they could increase moderate-intensity aerobic activities, such as walking to/on campus (Bopp et al., 2010; Reed & Phillips, 2005; Roemmich, Balantekin, & Beeler, 2014). However, when challenging PA tasks requiring higher self-efficacy (e.g., competitive sports and weight training) were involved, the role of physical environment became complex, as more characteristics (e.g. proximity of facilities, quality of equipment, and social atmosphere) joined to play a role. In other words, students may take advantage of available PA resources in the physical environment. However, the positive effects may also be suppressed by their individual and social determinants such as self-efficacy and social support. Although previous research has found different environmental effects on MVPA and VPA (Li et al., 2016), the current study added to the knowledge basis about PA and settings by identifying the different environmental effects between aerobic activities requiring lower skill levels and other activities such as weight lifting requiring higher levels of knowledge and/or skills.

Achievement goal theory. The interactions among different levels had caused a complex factor-outcome relationship. Motivation as one of the psychosocial factors, has been suggested to highly influence students' PA participation (Lochbaum, Lichfield, Podlog, & Lutz, 2013). However, our knowledge of how motivators vary by context and setting is poor (Atkin, van Slijs, Dollman, Taylor, & Stanley, 2016). In order to better interpret the interaction outcomes of social and physical environmental influences on PA, it is beneficial to apply achievement goal theory (Nicholls, 1989) to interpret students' perception of PA experience in the unique campus setting.

According to Nicholls (1989) individuals evaluate their competence or define success and respond in the cognitive, affective, and behavioral domains. An advanced achievement goal theory was proposed by Elliot (1997) that differentiated valence and goal dimensions. The valence dimension focused on approach (i.e. positive possibility) and avoidance (i.e. negative possibility); while the goal dimension focused on mastery (i.e. evaluating the task itself) and performance (i.e. comparing performance against others) (Elliot & McGregor, 2001). By crossing the two dimensions, four achievement goal orientations are developed: mastery-approach, mastery-avoidance, performance-approach, and performance-avoidance.

In this study, two goal orientations were found useful in explaining the different responses to a mix of social and environmental influence. Students who considered themselves to be competent were likely to be more mastery-approach goal oriented. They had higher intrinsic motivation, strived for personal improvement, and perceived more enjoyment and satisfaction during PA (Adie, Duba, & Ntoumanis, 2010; Stevenson & Lochbaum, 2008; Wang et al., 2009). Those students were more likely to perceive social interaction during PA as a motivating factor, thus, sharing space and facilities with others did not cause anxiety for them. Similarly, performance-approach goal oriented students perceived higher competence and persistence, and less anxiety, therefore they had more intrinsic motivation to be physically active (Agbuga & Xiang, 2008; Lochbaum et al., 2013; Lochbaum, Podlog, Litchfield, Surles, & Hilliard, 2013; Wang et al., 2009). Results of this study were consistent with previous findings in that those who were involved in competitive sports or maintained in sports from an early age (i.e. high school) held more positive attitudes towards the social interaction and competitiveness during sports, which was their major source of leisure time PA.

In contrast, students who were more mastery-avoidance goal oriented presented negative feelings about PA such as incompetency and anxiety in a PA environment around better performers, embarrassment if there was a need of seeking for help, lower motivation for personal improvement (Adie et al., 2010; Lochbaum et al., 2013). Negative experiences were also found among the performance-avoidance goal oriented students in that they had higher anxiety but lower motivation (Agbuga & Xiang, 2008; Stevenson & Lochbaum, 2008). Students in this study who considered themselves as incompetent in certain activities, or unknowledgeable about certain exercise equipment, felt intimidated or embarrassed in a communal PA environment, even if no social interaction was taking place.

The findings supported the notion that better knowledge about self and the environment may lead to higher levels of confidence and competence that motivate positive behavior. It also revealed a need to promote PA awareness among college students so that they are more likely to embrace the positive experiences in a campus-based PA setting and combat the negative aspects of sharing space with the existence of competitiveness.

Research Question 2: What are the domains of college students' PA awareness?

In attempting to explore the answers to the first research question that examined how students understand their own PA, four primary domains (i.e. internal and external) emerged as the sources that consisted their perceptions of PA, which answered the second research question. Therefore, although the discussion on each research question was structured independently, the discussion of the second research question was intended to serve as an extension to the first research question, in order to categorize the aforementioned themes into specific names of PA domain. Specifically, the internal domain of PA awareness referred to perceptions of PA in relation to personal attributes such as recognition of PA benefits and needed personal improvement. The external domain referred to perceptions of PA experience in relation to the

external world such as social relations, environment, and relevant PA knowledge (i.e. action knowledge and PA recommendation).

Personal PA level

The internal domain of PA awareness refers to students' capability of understanding their own PA behavior in terms of self-monitoring or self-evaluating their own PA levels, and personal improvement. Self-evaluation is a key component of the self-awareness theory, without which, an individual could not recognize the lack of desirable behavior and the need for improvement (Duval & Wicklund, 1972; van Stralen et al., 2010). However, self-assessed PA has been a problematic area due to the overestimation by most individuals, consequently leading to their misconception of PA levels, thus, little to no intention for enhancement (Corder et al., 2011; Friedenreich & Matthews, 2007; Lahar et al., 2014). Students in this study believed that they know the various health benefits of PA as well as their lack of PA as indicated mainly by their self-perceived health rather than the actual PA levels, suggesting strong awareness of PA benefits but weak awareness of personal PA levels. It is suggested that for younger people (e.g. college students), knowing the health is not as important as other perceptions of other benefits such as enjoyment, social interaction, and self-improvement (Pan et al., 2009). Despite the fact that the students were able to conclude there is a need to improve their personal PA, it was unclear for them whether desirable performance is achieved without accurate information on their PA levels, therefore, the capability of evaluating one's own PA behavior should be a core component of PA awareness.

PA Recommendation Knowledge

Although previous studies (Heinrich et al., 2011; Lahart et al., 2014) focused on whether students were aware of the various health benefits of PA, the results of this study suggested that most students were able to illuminate how participation in PA would positively affect their physical and mental health. Additionally, studies have shown that there is no relationship between fitness knowledge and PA levels (Knox et al., 2012; Ward, 2014). Meanwhile, a study by Bodde and colleagues (2012) suggested knowledge regarding PA recommendation were positively associated with PA levels. The importance of "knowing the recommendations" has also been emphasized in the self-awareness theory, that awareness takes place with the recognition of the discrepancy between self and standards (refs). This study specifically focused on college students' knowledge of the PA recommendations by WHO, as it provides specific guidance that could assist them to achieve desirable outcomes (i.e. recommended PA levels that are essential for maintaining health). Unfortunately, the students lacked recognition of the PA recommendations and presented doubtful thoughts towards such information, indicating the need of raising awareness in scientific knowledge among college student, which is essential to guide them in setting specific PA goals and making action plans (Normand, 2008). Therefore, it is necessary to include PA recommendation knowledge as a critical subdomain of the external PA awareness.

College students as independent individuals hold their own perceptions regarding their own health behaviors. Meanwhile, as emerging adults, they are still learning new knowledge to better understand themselves and the outside world. The results of this study presented a challenge to the physical education profession that calls for more efforts to deliver accurate and useful information, upon which the students may build knowledge base to critically analyze their

own PA behavior, reflect on self-assessment, and set specific goals to guide their actions for improving or maintaining physically active behaviors.

Social Support

The results suggested that for college students, a great amount of PA awareness often come from their social interactions with family, friends and peers. The phenomenal impact of social relations on PA has been reported in numerous studies (e.g., Barfield & Hutchinson, 2012; Belanger & Patrick, 2018; Farren et al., 2015; Pauline, 2013, Zick et al., 2007). The results on how perceived social interactions in their PA experience served differently (i.e. motivating factors or barriers) provided additional evidence for self-efficacy accounting for the effect of perceived social support on PA (Haughton McNeill, Wyrwich, Brownson, Clark, & Kreuter, 2006; Motl, Dishman, Saunders, Dowda, & Pate, 2006). The positive aspects of social environment as reported in this study align with previous research that identified specific characteristics including companionship, encouragement, assistance and professional advice. More research is needed concerning how to increase the capability of overcoming negative social influence and seeking social support from others to embrace positive attitudes, learn relevant knowledge, and establish supportive network.

Environment

The uniqueness of college campus has made environment an indispensable subdomain of college students' PA awareness (Farren et al., 2015). Awareness of the physical environment in college setting refers to perception of PA facilities and resources in terms of accessibility, availability, quality, and regulations. The inclusion of environmental factors in PA awareness is supported by previous studies suggesting the positive effects of cues and opportunities on PA participation (Bogers et al., 2004; Eckel et al., 2009; Mosca et al., 2006; Pereral et al., 2014; Santos, Silva, Santos, Ribeiro, & Mota, 2008; van Sluijs et al., 2007). Unlike studies targeting public PA environment that reported safety as a major barrier to PA (Foster & Giles-Corti, 2008;

Moran et al., 2014; Saelens & Handy, 2008), this study specifically focused on the campus environment, therefore, did not find safety from crime to be a critical constraint to PA participation. Moreover, students' awareness of the physical environment should focus more than just availability of PA resources, as the results suggested students' perceptions of the accessibility, convenience and satisfaction are of more concern as they have stronger effects on PA participation (Huston, Evenson, Bors, & Gizlice, 2003). The environment awareness is of great importance in a college students' overall PA awareness, because the ability of exploring and learning about surrounding PA facilities developed during college years is likely to be carried into adulthood, potentially leading to higher PA engagement (Pan et al., 2009).

LIMITATIONS

In summary, the study took a phenomenographical approach in attempt to gain a comprehensive understanding of college students' experience and perception regarding PA, with the lens of self-awareness theory and social ecological model. However, there were several limitations in this study. The first limitation was lack of member-checking on the interview data. Given the nature of focus group interview, it was challenging to ask individual participants for their verification of the overall interpretation. Nevertheless, the researcher made a best effort at the interview site to avoid potential miscommunication through repeating and rephrasing participants' responses to confirm the accuracy of the information. Additionally, peer-debriefing was employed to minimize the researcher's bias. Second, it is possible that the sampling of participants was biased, given that the focus groups were formed from a pre-existing class at one state university. However, a brief background survey was conducted prior to the interview and information regarding students' gender, age, ethnicity, class standing, major and PA behavior

was examined, resulting in no major biased distributions in those characteristics. It might be based because the majority of participants were freshmen and the percentage of juniors and seniors was low (10%??). Future research that involves observation and other sources of data may be beneficial to the domain creation of PA awareness in college students.

CONCLUSIONS AND IMPLICATIONS

The results suggested students had relatively better perceptions of various health benefits of PA, but poor knowledge of their own PA levels due to the overlooking of PA recommendations. Students' perceived PA experience was strongly associated with their perceptions of the social and physical environment. The identified domains in PA awareness were self-PA levels, PA knowledge, social environment, and PA environment.

Increased PA awareness could contribute to changes in knowledge and behavior that improve health status in this population. As college students experience the transition from adolescents to emerging adults, the context in which they independently develop, establish, modify their own lifestyles, influence both their understanding and decision-making regarding PA. This study contributes to our understanding of college students' awareness related to PA, identifies how social and environmental contexts influence their perception of PA. Physical education is a main source from which students receive formal education and learn about accurate knowledge relevant to PA. While it is crucial to equip students with competence to be physically active, it is equally important to cultivate their mindfulness to track their own PA status, and pay attention to the dynamic context they live in. It is believed that students with proper understandings and analysis of the internal and external horizons should be able to make the right choice and benefit. Professionals in higher education settings planning for PA

interventions may benefit from hearing the perspectives of college students to adopt more effective approaches that integrate feasible PA opportunities across campus.

Future research should continue to verify the proposed constructs of PA awareness among college students, and develop a valid and reliable instrument that captures the various aspects of PA awareness. Moreover, examining PA awareness in relation to PA behavior may also contribute to the understanding of physical and psychological factors influencing students' PA participation. This study documented the complex influence of individual, social, and environmental factors on PA behavior. Understanding college students' ideologies in the specific context would provide valuable insights for developing effective intervention strategies for PA promotion, including college courses, campus structures, health services, and advocating for health-promoting policies. Therefore, future studies should consider the inclusion of these constructs to complete the missing piece of successful PA improvement in college students.

Chapter 4: Instrument Development for Measuring College Student PA Awareness – Study II

RESEARCH AIMS AND QUESTIONS

This study aimed to develop an instrument that measures self-perceived PA awareness among college students guided by psychometric theories. The domains and items embedded in each domain were developed based on the findings in Study I and the previous literature. The following two research questions were addressed quantitatively.

1. What domains and items can adequately capture college students' PA self-awareness?
2. What are the validity and reliability of the scale designed to measure college students' PA awareness?

CONCEPTUAL FRAMEWORK

Because no previous studies have examined PA awareness in college students**,** the following two theories were used to guide the development of the scale. The self-awareness theory provides the domain structure for the scale. The social ecological model (SEM) helps identify factors needed to be considered.

Self-awareness Theory

According to Duval and Wicklund (1972), when an individual focuses attention on the self and compare the self with standards that specify how one should think, feel or behave, referred as self-evaluation, the comparing process may lead to behavior change as an effort to reduce the discrepancies between their actions and ideals. Two key components are involved in the self-awareness process: knowledge about the standards and knowledge about self. Therefore, a framework based on self-awareness theory is used for constructing a PA self-awareness

questionnaire to measure students' knowledge of PA standards and knowledge of personal PA levels in Figure 5.

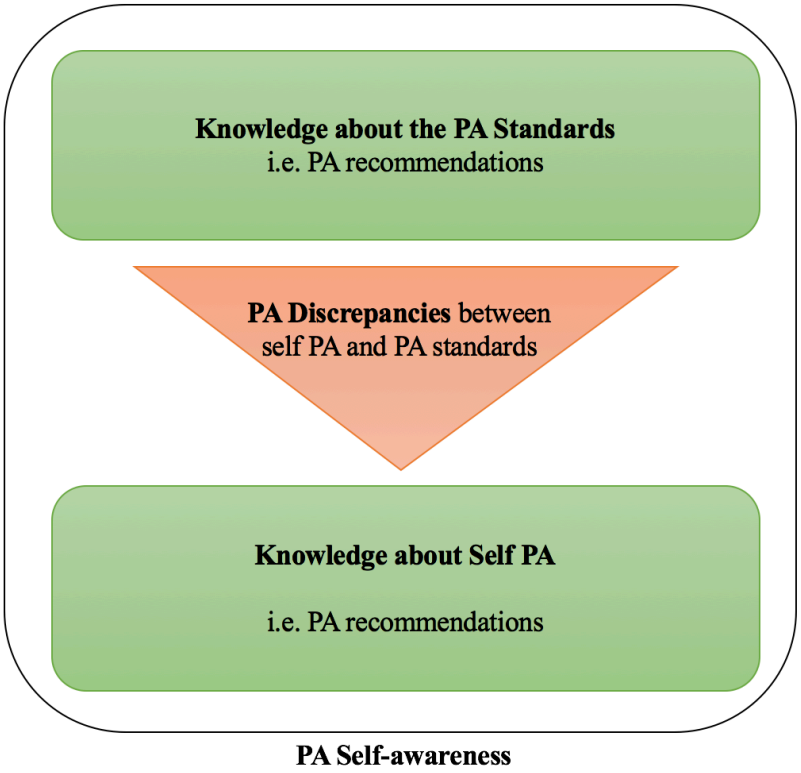

Figure 5: A Conceptual Framework of PA Awareness Based on Self-awareness Theory.

Social Ecological Model

The social ecological model (SEM) illustrates the multifaceted and interactive effects of individual and environmental factors that determine behaviors (McLeroy, Steckler, & Bibeau, 1988). The SEM consists of multiple levels of factors that may alter one's behavior (Golden & Earp, 2012). According to the structure of awareness framework, awareness is made up of three overlapping aspects that could be divided into internal and external horizons. While self-awareness theory focuses on self as the object, the SEM explicitly pays attention to the self-environment relations that exist across different dimensions of the external horizon, including physical, social and cultural environment, to describe the reciprocal and dynamic relationships

between self (the thematic field) and environment (the margin) (Stokols, 1996). Categories derived from Study I were compared with the proposed models to define PA awareness domains, in which items measuring awareness were generated. Figure 6 demonstrated how PA awareness is interactively measured in the instrument as a combination of SAT and SEM.

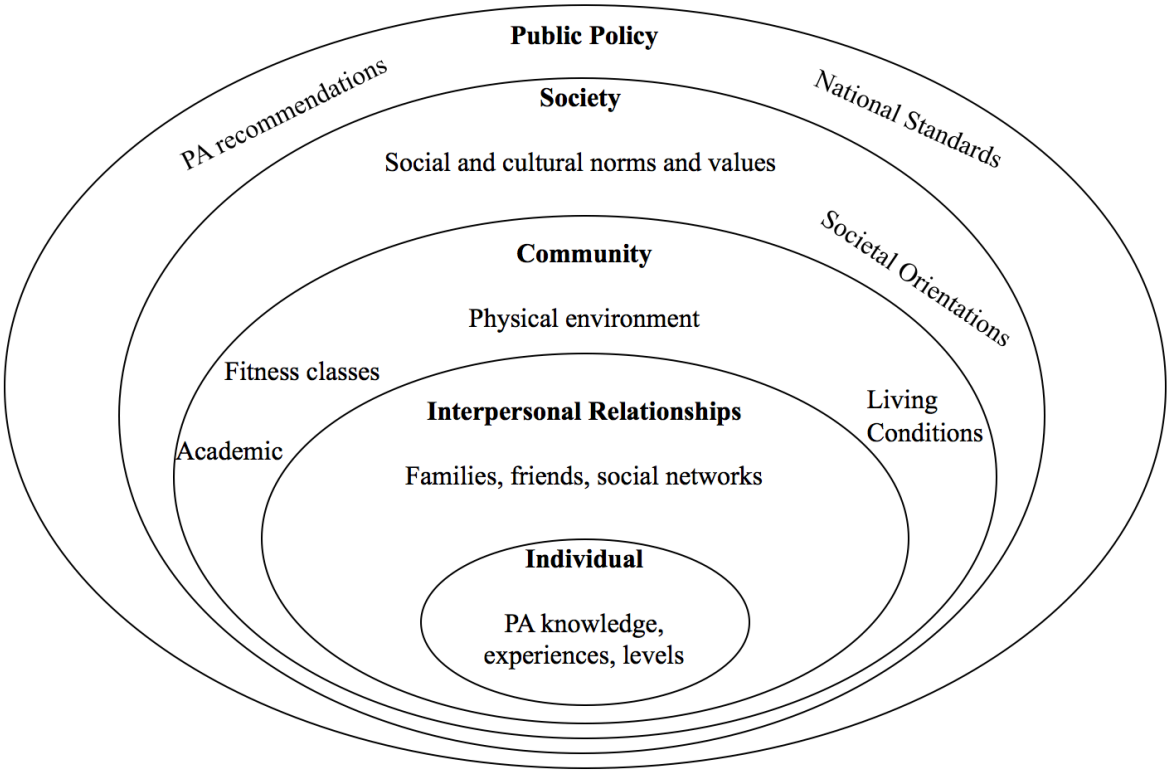

Figure 6: Adopted Framework of College Student PA Awareness Structure.

METHODOLOGY

Research Design

The purpose of this study was to determine whether the coverage of the instrument was appropriate and sufficient to measure PA awareness among college students. Initial items were written and firstly revised upon experts' feedback. Multiple phases were employed to achieve the goal of the study. The first phase focused on item construction to generate an initial version of

questionnaire that assesses awareness of PA on four levels included in the SEM. The second phase involved the content validity study and the final phase was devoted to the test of the construct validity and reliability of PA awareness scale using a sample of college student for whom it is designed for.

Phase I: Domain and Item Generation

Phase I aimed to develop a pool of items based upon the interview results of the previous study, and explore the item-domain relationships in the proposed PA awareness structure. Items were first drafted and discussed within a cohort of graduate students for feedback and comments, then reviewed by a professional writer for wording suggestions. The initial pool included items in three domains: ***(a) internal PA awareness*** consisted of a list of items regarding self-perceived levels of PA in three types (i.e. vigorous PA, moderate PA, and muscle strengthening PA) as well as respective personal goals, which were in line with the PA recommendation for adults by WHO; ***(b) external PA awareness*** included items related to perceived PA knowledge (i.e. PA recommendations), perceived social influence, and perceived physical environment especially related to the college setting that were found to be highly important from focus group results as well as previous research; ***(c) the interaction domain*** included items that focus on the extent to which individuals' PA behavioral decisions were influenced by aforementioned external factors (i.e. social and physical environment). Reverse worded items were used to ensure valid measures. Because PA awareness are conceptualized as propositions that one thinks to be true, all items were measured on a 7-point Likert scale, ranging from "strongly disagree" (i.e., scoring 1) to "strongly agree" (i.e., scoring 7) in order to generate variations needed for measuring latent variables (Groves et al. 2011).

Phase II: Content Validity

Phase II aimed to evaluate the content validity of the domains and items. Content validity refers to the extent to which the content of an instrument represents the content of an attribute it aims to measure. Experts in the field of interest are ideal judges who are often invited to critique the appropriateness of the instrument content, including professors, researchers and graduate students who have the expertise in the measured content area. The inter-item agreement among the experts is the evidence for content validity (Groves et al., 2011).

Procedure

Purposive sampling was used to recruit participants for the content validity study. A panel of experts (N = 10) in PA, fitness, health and measurement participated in the study. An online Qualtrics survey link of the instrument was sent to the experts by email, with the definition of PA awareness, and the definitions of the domains and subdomains. The experts were asked to evaluate the appropriateness of the domain and subdomains, the association between domain and subdomains, and the relevancy of items to the subdomains. In addition, the experts provided comments and suggestions concerning the domains and items, which were later incorporated in domain and item revisions.

Results

The experts' agreement on "internal awareness" domain was 80%, and the agreement on "external awareness" domain was 100%. However, only 70% agreement was achieved for the "interaction" domain, which consisted of items that were paralleled to the external to PA behaviors. Because of the low expert agreement and the experts' comments, the "interaction domain" and associated items were deleted. The scale consisted of 30 items after the expert

review. Eliminating those items not only simplified the structure of the subdomains, but also shortened the survey and made it more time-economic for participants to complete.

Phase III: Pilot Testing

After removing irrelevant and unfit items suggested by the experts in the above content validity study, remaining items were randomly listed in the survey without the domain identification. The draft version was then sent to 50 college students for pilot testing, aiming to gather users' feedback regarding their comprehension of the item content, comfortableness to use the online format (i.e. web-based and smartphone based), as well as general concerns and questions. Wording and format were slightly revised based upon students' feedback from the pilot testing. Their input generated useful insights for the wording, design and distribution of the survey. For example, the online format included web-based and smartphone-based version, which presented different layout and flow in taking the entire survey. For smartphone users, the survey was tested multiple times using different operating systems to ensure ease in filling out each question.

Phase IV: Field Testing

The final version of the scale (Appendix D-1) consisting of 30 items with two domains (four subdomains as indicated in the conceptual framework) was tested in 8 universities, with a total number of 1,122 undergraduate students participating in the study, among which 1045 provided complete data before data screening for further analysis.

Procedure

The recruitment of the participants took two forms: the researcher either contacted university class instructors to for their permissions to collect survey data in their class, or randomly distributed the survey to individual students around different campus areas, such as

library, cafeteria, and other open study spaces. In addition, the survey data were collected in both online and paper versions. Participants recruited from existing classes were offered the options to respond either through a secured web-link to the questionnaire, or a paper format. Meanwhile, participants recruited individually from campuses were provided paper and pens to complete the survey on site. A consent page was provided at the beginning of the survey. All respondents received the items in the same order. The estimated time to complete the questionnaire was about 15 minutes to reduce the likelihood of disengaging respondents (Worthington & Whittaker, 2006).

Data Analysis

Data screening was conducted to first eliminate cases with more than 50% missing values, and then outliers to ensure normality. A total number of 994 cases remained for construct validity and internal consistency. Correlations of the 30 items were analyzed first in SPSS V21 to identify highly correlated items, followed by a confirmatory factor analysis (CFA) using SPSS Amos 21.0 to test construct validity. The remaining items after CFA were then analyzed for internal consistency using Cronbach's alpha in SPSS V21.

Construct Validity

Construct validity examines the extent to which the relationships among items in the instrument are consistent with the theory and concepts (Waltz et al., 2010). Factor analysis is appropriate for evaluating construct validity by revealing the constructs that underlie responses to the items and determining which items to be included in a scale (Stevens, 2012). A CFA was used to determine if the hypothesized theoretical structure fits the data. A set of statistical indices were evaluated to examine the model fit, including standardized root mean square residual

(SRMR), root mean square error of approximation (RMSEA), goodness of fit index (GFI), normed fit index (NFI), and comparative fit index (CFI). In particular, indications of a good model fit include: (a) a SRMR value of 0.08 or less; (b) a RMSEA value of 0.06 or less; (c) a GFI value of over 0.9; (d) an NFI value of 0.95 or more; and (e) a CFI value of 0.95 or more (Meyers, Gamst, & Guarino, 2017).

Internal Consistency

Cronbach's alpha was used to measure the interrelatedness among items of the awareness scale to determine how well the items measure the same construct (DeVallis, 2016). Cronbach's alpha values ≥ .9 indicates excellent internal consistency, values ≥ .80 are considered to be good, and values ≥ .7 are considered to be moderate (DeVallis, 2016). Cronbach's alpha for both the total scale and subscales were calculated with values ≥ .70 to be acceptable (Netemeyer, Bearden, & Sharma, 2003). Pearson correlations for item-item, item-subscale, item-scale, subscale-subscale and subscale-scale were also calculated. Acceptable criterion for determining items to be kept are as following: (a) item-item correlations .30-.70; (b) item-subscale correlations ≥ .50; (c) item-scale correlations ≥ .40; (d) subscale-subscale correlations .40-.65; and (e) subscale-scale correlations .55-.80 (Devallis, 2016; Netemeyer et al., 2003).

RESULTS

Construct Validity

A CFA (N = 994) was performed in order to verify the proposed factors identified in proposed conceptual framework. The original model demonstrated poor model fit as the selected model fit indices were not within the acceptable ranges (see Figure 7). Therefore, model

revisions were deemed necessary. The examination of the modification indices led to re-specifying the model by removing 4 overloading (i.e. knowledge of PA self-estimation method and technological devices, knowledge of campus-wide health related events loaded on both personal PA factor and knowledge factor; knowledge of self-evaluated sedentary time loaded on personal PA, knowledge and environmental factors;) and 9 correlated items (i.e. knowledge of personal goal of each type of physical activity, knowledge of seeking support from coaches, knowledge of exercise equipment, sidewalks, campus-wide physical education policy, services and resources) as indicated in the model fit indices, as well as adding a path: (a) from "conceptual physical education courses" to "find needed support from professor"; (b) from "find needed support from professor" to "find need support from friends"; (c) "find needed support from professor" to "find need support from peers"; (d) from "perceived knowledge of recommended daily moderate to vigorous physical activity time" to "perceived weekly amount of moderate physical activity"; (e) from "perceived knowledge of recommended daily moderate to vigorous physical activity time" to "perceived amount of weekly vigorous physical activity"; and (f) from "perceived knowledge of recommended frequency muscle-strengthening physical activity" to "perceived amount of weekly muscle-strengthening physical activity". Overall, 13 items were removed and 6 paths were added to achieve best model fit. The re-specified model with 17 items was illustrated in Figure 8. The re-specified model achieved acceptable to excellent values of model fit indices (i.e., RMSR = .035, RMSEA = .046, GFI = .946, NFI = .954, CFI = .968). Therefore, there was an improved fit between the 4-factor structure and the data (Table 1).

Factor Model	RMSR	RMSEA	GFI	NFI	CFI
Proposed	.075	.094	.774	.720	.740
Re-specified	.035**	.046**	.946**	.919*	.967**

Table 1: Model Fit Indices for Confirmatory Factor Analysis.

Note: * indicated acceptable model fit; ** indicated excellent model fit; RMSR: standardized root mean square residual; RMSEA: root mean square error of approximation; GFI: goodness of fit index; NFI: normed fit index; CFI: comparative fit index.

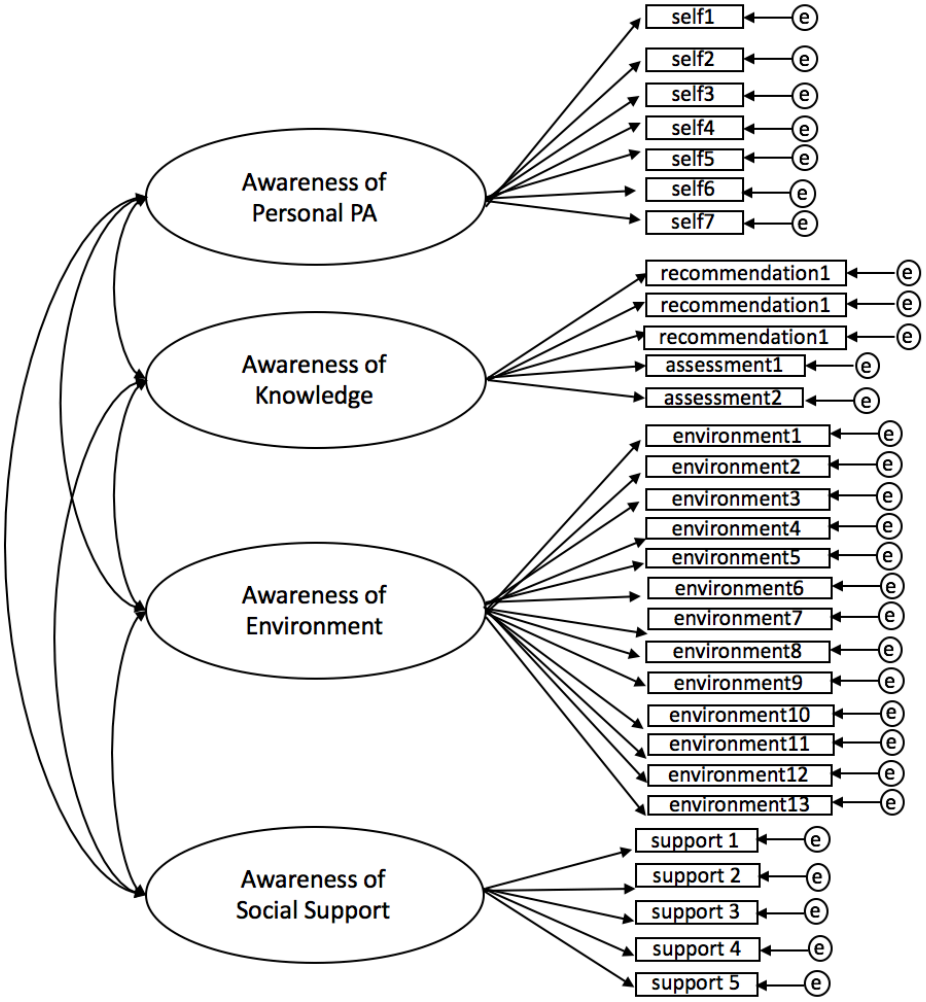

Figure 7: Structural Diagram for the Proposed Model of Physical Activity Awareness.

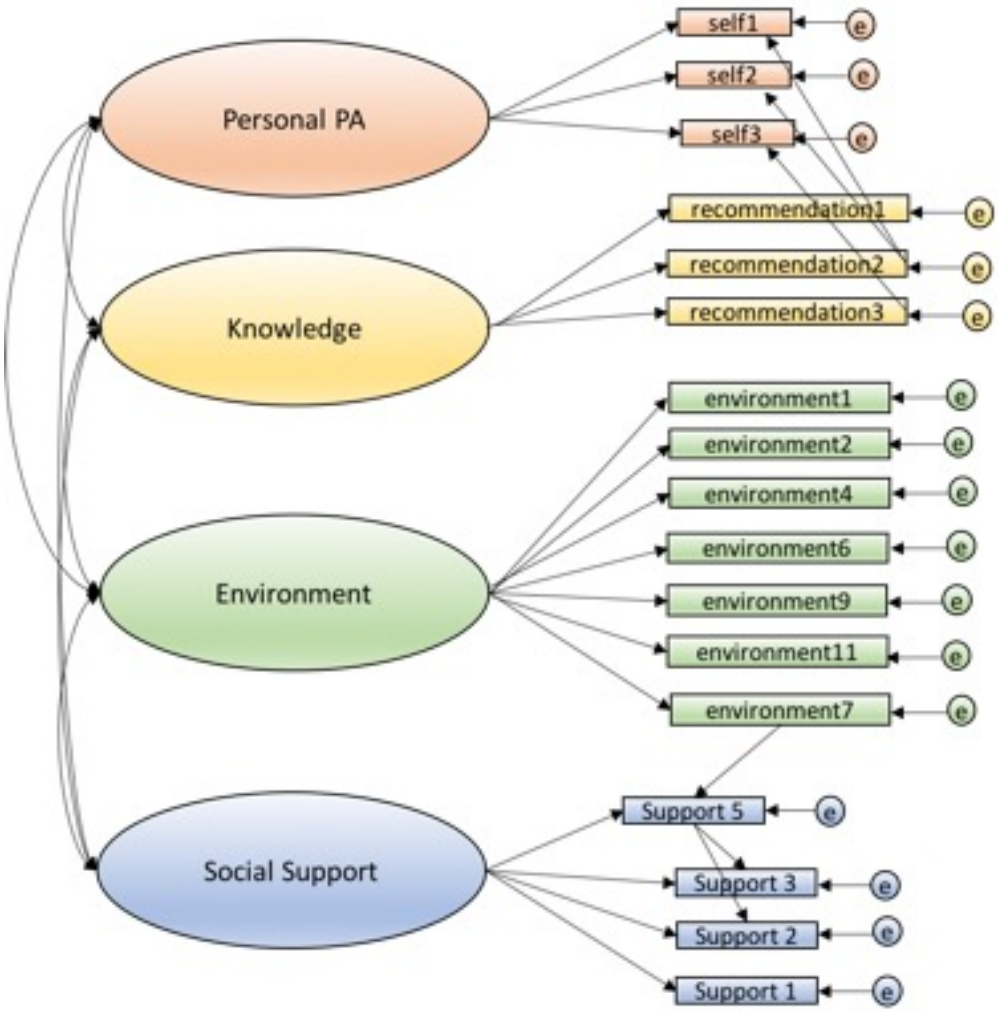

Figure 8: Structural Diagram for the Re-specified Model of Physical Activity Awareness.

Internal Consistency

The results indicated a good overall consistency of the scale. Excellent internal consistency was achieved within the component "recommendation knowledge". The component "personal PA" had an acceptable reliability, while "social support" and "environment" had acceptable internal consistencies (Table 2). Correlations among the four factors were moderate (Table 3). Item-item correlations within each awareness component were all also acceptable (see Table 4a-d).

Factor	Cronbach's Alpha	Number of Items
Personal PA	.823**	3
Social Support	.741**	4
Environment	.799**	7
Recommendation Knowledge	.919**	3
Entire Scale	.857**	17

Table 2: Internal Consistencies of the Scale and Factors.
Note: ** indicated significant correlations at .01 level.

	Personal PA	Social Support	Environment	Recommendation Knowledge
Personal PA	1			
Social Support	.166**	1		
Environment	.299**	.330**	1	
Recommendation Knowledge	.322**	.313**	.497**	1

Table 3: Factor Correlations.
Note: ** indicated significant correlations at .01 level.

	1	2	3
1. During a typical week, I know how much moderate physical activity I have performed.	1		
2. During a typical week, I know how much vigorous physical activity I have performed.	.630**	1	
3. During a typical week, I know how much muscle-strengthening physical activity I have performed.	.522**	.688**	1

Table 4-a: Item-Item Correlations within Personal PA Factor.
Note: ** indicated significant correlations at .01 level.

	1	2	3	4
1. I know how to find needed supported from my family	1			
2. I know how to find needed supported from friends	.534**	1		
3. I know how to find needed supported from my peers	.383**	.601**	1	
4. I know how to find needed supported from my professors	.263**	.252**	.478**	1

Table 4-b: Item-Item Correlations within Social Support Factor.
Note: ** indicated significant correlations at .01 level.

	1	2	3
1. I know about physical activity recommendations for young adults on daily total physical activity time.	1		
2. I know about physical activity recommendations for young adults on daily total moderate and vigorous physical activity time.	.838**	1	
3. I know about physical activity recommendations for young adults on frequency of muscle-strengthening physical activity per week.	.738**	.804**	1

Table 4-c: Item-Item Correlations within Recommendation Knowledge Factor.
Note: ** indicated significant correlations at .01 level.

	1	2	3	4	5	6	7
1. I know a great deal about the indoor facilities.	1						
2. I know a great deal about the outdoor facilities.	.430**	1					
3. I know a great deal about the accessible stairways.	.269**	.288**	1				
4. I know a great deal about the physical activity courses.	.451**	.383**	.278**	1			
5. I know a great deal about the conceptual physical education courses.	.368**	.365**	.374**	.594**	1		
6. I know a great deal about the group exercise classes.	.364**	.347**	.236**	.459**	.461**	1	
7. I know a great deal about the sports clubs.	.285**	.369**	.204**	.336**	.410**	.407**	1

Table 4-d: Item-Item Correlations within Environment Factor.
Note: ** indicated significant correlations at .01 level.

DISCUSSION

The evaluation of PA awareness represents one of the most important psychological aspects of PA behavior, however understudied. The lack of theoretically sound, valid and reliable instrument for measuring PA awareness has limited the potential to study the psychological effects on the comprehensive behavior change in PA research. This study aimed to validate a scale guided by psychometric theories that measures PA awareness among the college student population. It followed a qualitative study that explored how college student perceived their PA experience in relation to their mixed environment, which informed the generation of a large pool of items. The study included scale development and scale validation.

The results from CFA affirmed the shared PA experiences from Study I in that college students' PA awareness came from two main dimensions (i.e. internal and external), consisting of four components: personal PA, social support, environmental, and knowledge. The participant-item ration was over 50:1, surpassing the recommended ratio of 10:1, making a sufficient sample size to generate meaningful statistical power (DeVellis, 2016). Given the lack of existing scales that measure the complex aspects of PA awareness, the study made a remarkable contribution to the body of literature on this topic.

Development of the PA Awareness Scale

The instrument was developed through a number of steps, using previous interview data from college students for item generation, expert reviews for the content validity, a small sample size of college students for the pilot study, and a large sample size of college students for construct validity and reliability. The participants were appropriate for the purpose of the study as they represented the target population.

Sampling Issues and Response Rate

Response rate is an essential parameter to evaluate the effectiveness of data collection in research studies. A high response rate is critical to increase the validity of the results and generalize the findings (Erwin & Wheelright, 2002). However, it is often difficult to recruit participants in research. Therefore, a number of different approaches and survey formats were employed to collect sufficient data. The engagement of faculty member and graduate assistants helped greatly in recruiting a fair number of undergraduate students in their classes to participate in the study. Despite that researchers suggested the use of incentives as an effective way to increase response rate (Deutskens, De Ruyter, Wetzels, & Oosterveld, 2004; Jia-ming & Peiji, 2010; Singer & Ye, 2013; van Horn, Green, & Martinussen, 2009), there were no observations of increased response rates in online survey where extra credits were offered by the instructors in the current study. Unfortunately, it was unclear why the incentives did not work.

Given the mixed types and procedures applied in distributing the survey, it was not feasible to calculate the exact response rate in this study. However, it was shown that paper-based survey had much higher response rate than the online version, as most papers were returned at the time of on-site data collection, which mostly took place in their classroom with instructors' permission. It is interesting to note that even though a paper with QR code printed was provided to the students for convenient access to the survey link, the smartphone version was not used much by the students. Given the extremely low response rate for online survey, the primary researcher visited various campuses to distribute the paper-based survey, which consisted the majority of the responses (N = 750).

Although it is common that online survey has lower response rate (i.e. 11% lower) than other methods (Manfreda, Bosnjak, Berzelak, Haas, & Vehova, 2008; Petchenic & Watermolen,

2011; Shin & Fan, 2008), it should be note that with improvement in technology, the online survey has a number of advantages over paper-based administration, including low cost, flexibility to administer, ease of managing the data, and security for data collecting and storing (Cook, Heath, & Thompson, 2000; Eysenbach & Wyatt, 2002). Most importantly, using online survey may minimize the cases of missing data by changing the setting of a question so that the participants have to complete each question to move forward. However, it is also possible to result in increased drop-out rate as "forcing" the participants to answer every single question may lead to a feeling of frustration. Even though online surveys raised concerns such as difficulty to have a representative sample of the general public due to varied access to the internet (Carrozzino-Lyon, McMullin, & Parkhurst, 2013; Pedersen & Nielsen, 2014), it was not a problem in this study, as all students were enrolled undergraduate students with constant internet access.

Survey Length

Survey length is beneficial in increasing the reliability of the instrument, however, with an increasing chance of participants' inattentiveness along the time (Meade & Craig, 2012). Huang and colleagues (2012) defined a term "Insufficient Effort Responding (IER)" as a specific response set in which responder responds to survey measures with low or little motivation to comply with survey instructions, interpret item contents, or to provide accurate responses (Huang, Curran, Keeney, Poposki, & Deshon, 2012, p. 100). Previous research indicated that web-based surveys have a higher prevalence of IER than paper-based surveys (Fleischer, Mead, & Huang, 2015; Johnson, 2005; Meade & Craig, 2012), which partially explained the lower response rate of online survey in this study It is suggested to decrease survey length to prevent the occurrence of IER in conducting survey research.

Although the PA awareness scale takes approximately 10-15 minutes to complete, there were additional questions in the survey following the PA awareness scale for the purpose of Study III, which focused on other related measures such as the 7-day PA level recall using the IPAQ short form, four multiple choice questions that tested real PA recommendation knowledge, and demographic information (i.e. age, gender, ethnicity, height and weight, class standing, major, etc.). Therefore, it might have taken longer than 15 minutes for the participants to finish the entire survey, especially for the participants that were recruited randomly across different campuses, with the presence of distracting characteristics in the environment. The entire survey practically took longer than estimated (i.e. 20-30 minutes). However, it was not deemed as a long survey (i.e. 30-45 minutes), as defined by Galesic and Bsonjak (2009).

Construct Validity

Construct validity was investigated using CFA. The total number of item was reduced from 30 to 17 to achieve a good model fit. Results of CFA supported the respecified four-factor model, indicating the scale measured four distinct but related constructs. In addition, the final set of items demonstrated face validity, reflected findings from previous literature on the importance of self-evaluation, social support, environment influence and knowledge on PA behavior (Cleland, Timperio, Salmon, Hume, Telford, & Crawford, 2011). Specifically, four factors were identified to delimitate PA awareness in this study: (a) personal PA awareness, defined as the capability of self-evaluating one's own PA behavior; (b) social support awareness, defined as the capability of finding PA support from social relationships; (c) environmental awareness, defined as the knowledge of PA opportunities in the accessible environment; and (d) knowledge awareness, defined as the knowledge of desired PA behaviors. The four-factor model confirmed

the structure of the proposed conceptual framework, combining self-awareness theory and social ecological model.

While self-perceived PA levels and PA knowledge have been studied as important indicators of PA awareness in previous studies (Bennett et al., 2009; Berry et al., 2016; Lahart et al., 2014; van Sluijs et al., 2007), only one factor (i.e. self-reported PA or knowledge) was assessed each time, missing the other three factors as suggested in this instrument. While it is important for an individual to have proper knowledge of PA principles and one's own PA levels, we must also consider the imperative effects of social support and environment on one's PA behavior, in order to provide a more comprehensive description of what should be measured in PA awareness.

The low correlation ($r = .166$) between personal PA awareness and social support awareness revealed a high discrimination between these two aspects of PA awareness. Unexpectedly, the correlation between knowledge awareness and environmental awareness was the highest (i.e. $r = .497$) among all correlations, given that they were two discrete constructs. The other correlations were moderate (i.e. ranging from .299 to .330), suggesting moderate discrimination among the subscales. It is reasonable to suggest an underlying cause for the shared variance of these factors (i.e. personal PA, social support and environment) as they were more likely to relate to each other for a regular college student. For example, a student with higher levels of awareness on self-PA is more likely to pay more attention to PA facilities and social support in order to maintain a desirable personal PA level. However, further investigation is needed to explore possible explanations for the correlations among the factors.

Reliability

In the development of the instrument, internal consistencies for the overall scale as well as each factor were assessed. The Cronbach's alpha coefficient for the entire scale was greater than .80, indicating acceptable reliability among the sample of college students (Myers et al., 2013). All between-factor correlations were significantly positive, suggesting that the factors consistently measure of the level of PA awareness. Although relationships between some of the measures in the scale and PA behavior have been observed in previous studies (Bauman et al., 2012; Shibata, Oka, Harada, Nakamura, & Muraoka, 2009; Simons et al., 2017; van Dyck et al., 2011), to my knowledge, no instruments for assessing PA have been tested for reliability. Therefore, this study contributes to the growth of literature on measurement of PA awareness in college setting.

Reliability for Personal PA Awareness and Recommendation Knowledge Awareness

The three items of personal PA assessment awareness and three items of recommendation knowledge awareness demonstrated relatively better internal consistencies (α = .823 and (α =.919, respectively). The items were designed to measure the extend to which students are aware of their own participation levels for each type of PA (i.e. moderate PA, vigorous PA, muscle strengthening PA), as well as the respective PA recommendations. The high consistencies confirmed the importance of an individual's ability of self-monitoring (PA assessment awareness) and goal setting (knowledge awareness) on PA behavior change (Normand, 2008; Wack et al., 2014). Self-reported PA, as a most widely used way for self-monitoring, has been used in the vast majority of PA research, however, individuals are prone to systematic self-report bias, resulting in overestimation of desirable behavior (Johnson & Richter, 2004; Sallis &

Saelens, 2001). It should be noted that the three items in the personal PA awareness subscale aimed to assess the extent to which students were aware of their PA levels rather than their self-estimated amount of PA to avoid erroneous conclusions.

Reliability for External Awareness: Social Support and Environment

The internal consistencies for social support and environment awareness were acceptable , although they were slightly lower than the other components (α = .741 and .799 respectively). Given that these contextual attributes (i.e. social environmental factors) were more dynamic and amenable to change (Brownson, Hoehner, Day, Forsyth & Sallis, 2009; Yen & Kaplan, 1999), it is reasonable to assume that these items may generate relatively lower consistencies.

Recent studies have explored the measurement of social and environmental factors and their association with PA behavior (Bauman et al., 2012; Brownson et al., 2009; Shibata et al., 2009; Simons et al., 2017; van Dyck et al., 2011), warranting a brief discussion of measurement issues regarding social environmental factors. PA studies have directly examined the quality of the environment, such as perceived presence or lack of PA resources, and objectively measured quantity of available characteristics (Hoehner, Brenna Ramirez, Elliott, Handy, & Brownson, 2005). No studies have examined the accuracy of such perceptions by participants. In other words, it was not clear to what extend those participants were aware/knowledgeable of their social or physical environment.

In essence, the scale contained an appropriate number of items (i.e. n = 17), which only takes about 5 to 10 min. to complete. It is more likely that participants would take the survey when they are asked because it does not take too much time to complete it, increasing the feasibility of using the instrument. More importantly, the instrument supported existing theories in that it consisted of both internal and external awareness highlighted in SAT as well as the

multilevel constructs in SEM. As a result, it provided a valid and reliable measurement of PA awareness among college students in the US.

LIMITATIONS

There were a few limitations in Study II. First, the relatively long length of the original survey (i.e. 30 items) may have precluded participants from completing all questions and responding with carefully chosen answers. Second, the sampling methods may limit its generalizability in that participants were mainly from universities in one state; therefore, other states were not represented. Third, given the small sample size of the pilot study, it could not serve the purpose for pilot testing the validity and reliability of the scale. Lastly, test-retest reliability was not used due to the sampling strategy. Nearly half of the participants were recruited randomly from different campuses, making it impossible to re-recruit them for a retest.

Despite the limitations, there were strengths of the study. First, the sample size was large (N = 994). The sample was large enough to conduct factor analysis so that the results were statistically powerful. Second, the data supported the hypothesis that college student PA awareness was a measurable concept involving multilevel domains. Third, the four distinct constructs were confirmed with acceptable reliability and validity. Thus, the final instrument reflected the hypothesized dimensionality.

CONCLUSIONS AND IMPLICATIONS

In summary, a number of PA awareness variables were included in the instrument, including personal PA assessment, social support, physical environment and recommendation knowledge, which were key venues for PA promotion (Bennett et al., 2009; Berry et al., 2016; Lahart et al., 2014; van Sluijs et al., 2007). Compared to previous studies examining PA

awareness by assessing single aspect such as self-reported PA or prevalence of PA related knowledge, this instrument is advanced in that it covers a comprehensive set of elements based on self-awareness theory and social ecological model. Therefore, the instrument might be the scale for assessing college students' perceptions and knowledge about their own PA behavior as well as PA awareness focusing on social support, facilities, resources, and information existing in the specific environment. Moreover, the instrument could be used in further studies in association with PA behavior, to shed new light on future research in evaluating effectiveness of campus PA promotions from the PA awareness perspective. It is also promising in the enhancement of PA-promoting campus environment by focusing on the PA awareness items.

Chapter 5: Examination of College Students' PA Awareness, Knowledge and Behavior – Study III

RESEARCH QUESTIONS AND HYPOTHESES

The primary purpose of this study was to evaluate the level of PA awareness among college students using the validated instrument in Study II. The secondary purposes were to examine the relationships between PA awareness, PA behavior and relevant knowledge, as well as the differences in PA awareness by students' characteristics, such as gender, ethnicity, year in college, and major. Two research questions were explored, followed by related hypotheses.

1. What are the effects of gender, ethnicity, major, and class standing on students' PA awareness?

Hypothesis 1(a): there are interaction effects of gender, ethnicity, major, and class standing on college students' PA awareness.

Hypothesis 1(b): college students' PA awareness is significantly different by gender.

Hypothesis 1(c): college students' PA awareness is significantly different by ethnicity.

Hypothesis 1(d): college students' PA awareness is significantly different by major.

Hypothesis 1(e): college students' PA awareness is significantly different by class standing.

2. What are the relationships among PA awareness, PA knowledge, and PA behavior?

Hypothesis 2(a): college students' PA awareness is positively correlated to their PA recommendation knowledge.

Hypothesis 2(b): college students' PA awareness is positively correlated to their PA behavior.

Hypothesis 2(b): college students' PA recommendation knowledge is positively correlated to their PA behavior.

METHODOLOGY

Research Design

A cross-sectional design was applied using the instrument developed in Study II to examine college students' PA awareness, knowledge, and behavior. It should be noted that the data collection for Study III was completed in Study II. However, the removed items as suggested by results of Study II were not included in the data analysis of Study III. Because the survey items used in the current study were the remaining ones in Study II and no new items and domains were added after Study II, it was possible to collect the data at the same time as these for Study II.

Instruments and Procedures

All measures were assessed collectively in one survey, including four different sections: PA awareness, PA behavior, knowledge test, and participants' demographic information.

PA Awareness Scale

Physical activity awareness was assessed using the validated scale from Study II (Appendix D-2). Overall, 17 items were used to measure the four components of PA awareness: personal PA assessment (3 items), social support (4 items), physical environment (7 items), and recommendation knowledge (3 items). All items were measured on a 7-point Liker scale, with 1 representing lowest level of awareness and 7 representing highest level of awareness.

International Physical Activity Questionnaire

The International Physical Activity Questionnaire (IPAQ short form, Appendix E) was a validated scale that aimed to collect data as an indicator of weekly PA behavior (Craig et al., 2003; Lee, Macfarlane, Lam, & Stewart, 2011; van Poppel, Chinapaw, Mokkink, van Mechelen, & Terwee, 2010). Questions were categorized into 4 sections: moderate PA (MPA), vigorous PA (VPA), walking and sitting. Specifically, participants were asked to recall the frequency (i.e. days) and durations (i.e. minutes) of each type of activity during the past 7 days. Hours of sitting time each day were also reported. Data were converted into metabolic equivalents (MET) value in order to calculate the total PA as an indicator of PA behavior. The following protocol was followed to calculate total PA in MET.

- Walking MET-minutes/week = 3.3 * minutes per day * days per week in which walking was reported.

- Moderate MET-minutes/week = 4.0 * minutes per day * days per week in which moderate intensity activity was reported.
- Vigorous MET- minutes per week = 8.0 * minutes per day * days per week in which vigorous intensity activity was reported.
- Total physical activity MET-minutes/week = Walking + Moderate + Vigorous MET minutes/week scores.

The guidelines (IPAQ Research Committee, 2005) suggested that an individual

(1) must engage in 7 or more days of any combination of walking, MPA or VPA achieving a minimum total PA of at least 3000 MET-minute per week to score "high";

(2) must engage in 5 or more days of any combination of walking, MPA or VPA achieving a minimum total PA of at least 3000 MET-minute per week to score "moderate";

(3) should score "low" if not meeting any of the criteria for moderate of high levels of PA.

PA Recommendation Knowledge Test

Four multiple questions (Appendix F) were generated based on the PA recommendations for adults 18-64 by the World Health Organization (WHO). The first three questions asked about recommended PA amount for MPA, VPA, and MSPA, while the last question attempted to capture their understanding of recommended duration of aerobic activity. One point was granted for each correct answer. Therefore, the score for this part ranged from 0-4. This part was intended to test participants' true knowledge

regarding PA recommendation, by comparing it with their awareness of recommendation knowledge.

Study Context and Participant Recruitment

As noted earlier, the current study took place simultaneously with Study II, in which all data collected from 1121 full-time college students in eight universities in the state of Texas and three universities in other states. The survey was distributed in two formats: online through Qualtrics, and by paper in person. For the online survey, individual links for each class were first sent to the instructors through email. The links were then shared to different classes by the instructors. For the paper survey, students were recruited from classes as well as individually at different locations on the campuses. Specifically, the students were provided a hard copy of the survey and a pen to complete the survey on site (i.e. where the survey was distributed). The data collected by paper were input into excel file and combined with data that was collected online. The reason for adding the paper version was that the online survey did not yield a sufficient sample to generate enough statistical power for inferential data analyses. Although the two data collection methods are certainly different, the researcher made sure not to influence participants' answers by eliminating any physical and verbal interactions with the participants when using the paper survey. By doing so, the two methods were deemed almost identical, controlling the possible impact of the researcher's presence. Furthermore, all participants did not have any personal contact with the researchers.

Participant Characteristics

A set of questions regarding participants' characteristics were included at the end of the survey, including participants' age, gender, ethnicity, class standing, major, and living status (Appendix G). After data screening, a total number of 994 participants were included in this study. The average age was 19.66 ± 3.66. Students were grouped by gender, ethnicity, year in college, and major, respectively. In general, more than half of the participant were female (60.2%). Students were mainly Caucasian (33.1%), Hispanic (31.3%), Asian (17.5%) and African American (12.1%). About one third of the participants were freshmen (34.2%), and each of the other class standings were around 20%. Additionally, students were recruited in all majors (Physical Education/Kinesiology = 16.2%, Health-related (non-Physical Education/Kinesiology) = 15.4%, STEM = 24%, Liberal Arts = 19.1%, Business = 8.4%, Other = 11.2%, Undeclared = 3.2%). The majority of the participants were normal weight (60.9%), and about 30% were overweight (22.7%) or obese (7.5%). Detailed information regarding students' demographics were presented in Table 5. It should be noted that major was recoded into two categories representing physical education/kinesiology majors and non-physical education/kinesiology majors for further analyses.

		N	%
Gender	Male	377	37.9%
	Female	599	60.2%
	Missing	18	18.1%
Ethnicity	African American	120	12.1%
	Asian	174	17.5%
	Caucasian	329	33.1%
	Hispanic/Latino	311	31.3%
	Native American	5	0.5%
	Other	37	3.7%
	Missing	18	18.11%
Class Standing	Freshmen	340	34.2%
	Sophomore	206	20.7%
	Junior	218	21.9%
	Senior	194	19.5%
	Other	15	1.5%
	Missing	21	2.1%
Major	Physical Education/Kinesiology	161	16.2%
	Health-related	153	15.4%
	Liberal Arts	190	19.1%
	Business	83	8.4%
	STEM	239	24.0%
	Other	111	11.2%
	Undeclared	32	3.2%
	Missing	25	2.5%
SES	< $20,000	173	17.4%
	$20,000 - $49,999	160	16.1%
	$50,000 – $99,999	147	14.8%
	$100,000 – $199,999	163	16.4%
	> $200,000	74	7.4%
	Not Sure	256	25.8%
	Missing	21	2.1%
BMI	Underweight	50	5.0%
	Normal	605	60.9%
	Overweight	226	22.7%
	Obese	75	7.5%
	Missing	38	3.8%
Living Status	On Campus	308	31.0%
	Off Campus	664	66.8%
	Missing	22	2.2%

Table 5: Participant Demographics in Study III.

Data Analysis

A number of data analytic procedures were applied for the purpose of each research question and testing corresponding hypotheses. Specifically, descriptive, correlational, and comparative data analysis were used to interpret relationships among different concepts. Data were screened prior to any analysis. Extreme outliers were excluded from the data set to ensure normal distribution. All data analyses were conducted in SPSS V21 and AMOS V21.

Descriptive statistics were used examine to what extend college students are aware of PA in terms of the five components identified in the previous study. Means and standard deviations of component were calculated. The percentage of correct answers of each PA recommendation knowledge question, as well as overall knowledge score were calculated.

Correlation analysis was used to test the hypotheses for research question 2, to explore the correlations among awareness, knowledge and behavior. Furthermore, a path analysis was conducted using a proposed model to explore relationships between the five PA awareness components, PA recommendation knowledge, PA behavior, and personal characteristics. A set of statistical indices were evaluated to examine the model fit, including standardized root mean square residual (SRMR), root mean square error of approximation (RMSEA), goodness of fit index (GFI), normed fit index (NFI), and comparative fit index (CFI). In particular, indications of a good model fit include: (a) a SRMR value of 0.08 or less; (b) a RMSEA value of 0.06 or less; (c) a GFI value of over

0.9; (d) an NFI value of 0.95 or more; and (e) a CFI value of 0.95 or more (Meyers, Gamst, & Guarino, 2017).

Four-way multivariate analysis of variance (MANOVA) was applied to test group difference by gender, ethnicity, major, and class standing. The dependent variables were PA awareness, PA knowledge and PA behavior. The independent variables were categorical variables including gender, ethnicity, major, and class standing. Individual main effect and interaction effects of these factors were examined.

RESULTS

PA Awareness

Means and standard deviations of the four components of PA awareness were reported in Table 6. One-way MANOVA was first used to briefly examine group differences by gender, ethnicity, major and class standing.

The one-way MANOVA using gender as the independent variable results suggested that gender had a significant effect on PA awareness [Wilk's Lambda = .984, $F(4,920) = 3.724$, $p = .005$, $\eta^2 = .016$]. The univariate test indicated that male students had higher awareness of personal PA levels [$F(1,923) = 2.108$, $p = .004$, $\eta^2 = .009$], and recommendation knowledge [$F(1,923) = 6.396$, $p = .012$, $\eta^2 = .007$].

Major had a significant effect [Pillai's Trace = .147, $F(4,920) = 39.769$, $p < .001$, $\eta^2 = .147$]. Students in physical education/kinesiology major had highest levels of awareness in all components ($p < .001$).

Class standing had a significant effect on PA awareness [Wilk's Lambda = .968, F(12,2429.091) = 2.504, p = .003, η^2 = .011]. The univariate test indicated differences in awareness of personal PA levels [F(3,921) = 4.520, p = .004, η^2 = .015], and physical environment [F(3,921) = 5.566, p = .001, η^2 = .018]. Specifically, freshmen had the lowest PA awareness in personal PA levels (p = .004), physical environment (p = .001), and recommendation knowledge (p = .045).

No effect of ethnicity was observed, however, living status was found to have a significant effect on PA awareness [Wilk's Lambda = .983, F(4,918) = 3.926, p = .004, η^2 = .017]. The univariate test indicated differences in awareness of personal PA levels [F(1,921) = 9.801, p = .002, η^2 = .011], and recommendation knowledge [F(1,921) = 6.876, p = .009, η^2 = .007]. Interestingly, students who lived on campus had lower awareness of PA levels (p = .003) and recommendation knowledge (p = .009) comparing to those who lived off campus. However, no differences in awareness of social support and physical environment were found. No significant effect of ethnicity was found.

A four-way MANOVA was performed to examine the effects of gender, ethnicity, major and class standing on overall PA awareness. No interaction effects were found. Major had an individual effect on the overall PA awareness [Pillai's Trace = .052, F(4,852) = 11.663, p < .001, η^2 = .052].

The univariate test indicated that major had a significant effect on two components of PA awareness: physical environment [F(1,69) = 48.974, p < .001, η^2 = .043]. and recommendation knowledge [F(1,69) = 68.808, p < .001, η^2 = .032]. Specifically, students in physical education/kinesiology majors were more

knowledgeable of their physical environment for PA participation, and the PA recommendations. Comparisons of PA awareness components by major were presented in Table 7.

		M (SD)			
		Personal PA	**Social Support**	**Environment**	**Recommendation Knowledge**
Total		5.24 (1.45)	4.30 (1.33)	4.71 (1.18)	4.21 (1.66)
Gender	Male	5.42 (1.41)**	4.28 (1.32)	4.72 (1.11)	4.38 (1.61)**
	Female	5.13 (1.47)	4.31 (1.34)	4.71 (1.22)	4.10 (1.69)
Ethnicity	African American	5.29 (1.55)	4.41 (1.42)	4.92 (1.18)	4.31 (1.75)
	Asian	4.93 (1.60)	4.08 (1.28)	4.55 (1.07)	3.96 (1.64)
	Caucasian	5.42 (1.40)	4.39 (1.31)	4.69 (1.17)	4.25 (1.63)
	Hispanic/Latino	5.23 (1.38)	4.29 (1.35)	4.75 (1.24)	4.29 (1.69)
	Native American	4.60 (1.52)	3.55 (.78)	4.91 (1.50)	4.40 (1.44)
	Other	5.06 (1.30)	4.31 (1.27)	4.60 (1.08)	3.88 (1.44)
Class Standing	Freshmen	5.02 (1.48)**	4.32 (1.30)	4.56 (1.21)**	4.02 (1.66)**
	Sophomore	5.21 (1.53)	4.27 (1.39)	4.61 (1.16)	4.16 (1.65)
	Junior	5.36 (1.39)	4.18 (1.36)	4.81 (1.13)	4.33 (1.65)
	Senior	5.44 (1.39)	4.45 (1.29)	4.97 (1.14)	4.40 (1.63)
	Other	6.07 (.82)	4.05 (1.37)	4.55 (1.29)	4.86 (1.86)
Major	Physical Education/Kinesiology	5.84 (1.12)**	4.80 (1.20)**	5.58 (.92)**	5.47 (1.29)**
	Non-Physical Education/Kinesiology	5.12 (1.48)	4.20 (1.34)	4.54 (1.15)	3.96 (1.61)
SES	< $20,000	5.23 (1.42)	4.16 (1.43)	4.70 (1.20)	4.10 (1.82)
	$20,000 - $49,999	5.20 (1.50)	4.00 (1.39)	4.68 (1.25)	4.19 (1.70)
	$50,000 – $99,999	5.25 (1.57)	4.27 (1.32)	4.65 (1.30)	4.09 (1.76)
	$100,000 – $199,999	5.29 (1.38)	4.48 (1.30)	4.73 (1.03)	4.37 (1.52)
	> $200,000	5.44 (1.26)	4.65 (1.08)	4.79 (.85)	4.44 (1.41)
	Not Sure	5.18 (1.49)	4.39 (1.28)	4.74 (1.21)	4.18 (1.62)
BMI	Underweight	5.13 (1.57)	4.06 (1.56)	4.19 (1.23)	3.46 (1.66)**
	Normal	5.25 (1.46)	4.37 (1.35)	4.73 (1.18)	4.19 (1.66)
	Overweight	5.36 (1.38)	4.20 (1.23)	4.80 (1.09)	4.38 (1.64)

	Obese	4.89 (1.53)	4.24 (1.34)	4.67 (1.30)	4.28 (1.63)
Living Status	On Campus	5.01 (1.56)**	4.34 (1.33)	4.62 (1.20)	4.00 (1.65)**
	Off Campus	5.35 (1.39)	4.28 (1.33)	4.75 (1.17)	4.30 (1.66)

Table 6: Means and SDs of PA Awareness Components.
Note: *indicated significant difference at $p < 0.05$ level; ** indicated significant differences at $p < 0.01$ level.

	Personal PA	**Social Support**	**Physical Environment**	**Recommendation Knowledge**
PE/Kinesiology	5.85 (1.10)	4.81 (1.19)	5.58 (.90)**	5.45 (1.28)**
Non PE/Kinesiology	5.11 (1.49)	4.21 (1.34)	4.54 (1.14)	3.95 (1.61)

Table 7: Comparisons of PA Awareness Components by Major.
Note: ** indicates significant difference at $p < 0.01$ level.

PA Behavior

Overall PA

In total, 28.0% of the students did not participate in any vigorous physical activity (VPA), and 18.1% did not participate in any moderate physical activity (MPA). The majority of the students (95.9%) had walked at least once during the past week, and nearly half of them (56.34%) indicated at least 10-min daily walk. According to criteria of IPAQ short form guidelines, 50.1% of the students scored "high", while 27.1% scored "moderate" and 22.8% scored "low".

Total PA levels were assessed using the total weekly MET calculated from the IPAQ items. METs for each type of PA were presented in Table 8. One-way MANOVA was first used to briefly examine group differences by gender, ethnicity, major and class standing. Specifically, gender had a significant effect [Wilk's Lambda = .967, $F(3,826) = 9.375$, $p < .001$, $\eta^2 = .033$]. Male students had higher weekly VPA than their female counterparts ($p < .001$). Additionally, major had a significant effect [Pillai's Trace = .039, $F(3,826) = 11.149$, $p < .001$, $\eta^2 = .039$]. Students in physical education/kinesiology majors had significantly greater amount of weekly VPA ($p < .001$) than students in other majors. No effects were found for ethnicity or class standing.

A four-way MANOVA was performed to examine the effects of gender, ethnicity, major and class standing on PA behavior. No interaction effects were observed. Major had an individual effect on the overall PA behavior [Pillai's Trace = .026, $F(3,758) =$

6.750, $p < .001$, $\eta^2 = .026$]; Gender also had an individual effect on the overall PA behavior [Pillai's Trace = .010, F(3,758) = 2.610, $p = .05$, $\eta^2 = .010$]. The univariate test indicated VPA differed by major [F(4,69) = 17.763, $p < .001$, $\eta^2 = .023$]. Specifically, students in physical education/kinesiology majors had higher levels of VPA. Comparisons of PA awareness components by major were presented in Table 9.

		M(SD)		
		VPA	**MPA**	**Walking**
Total		1648.48 (1861.16)	1164.33 (1269.19)	1656.23 (1364.12)
Gender	Male	2140.44 (2048.39)**	1265.09 (1161.83)	1549.17 (1313.79)
	Female	1347.51 (1668.39)	1104.52 (1326.27)	1722.23 (1391.37)
Ethnicity	African American	1811.43 (2375.90)	1261.57 (1804.13)	1660.94 (1545.67)
	Asian	1423.37 (1628.29)	1028.49 (1174.76)	1628.66 (1244.76)
	Caucasian	1624.48 (1820.54)	1158.61 (1147.85)	1531.31 (1233.84)
	Hispanic/Latino	1718.20 (1760.63)	1191.06 (1200.34)	1794.83 (1487.87)
	Native American	864.00 (1455.91)	570.00 (452.99)	1361.25 (964.51)
	Other	1933.11 (2208.08)	1406.45 (1454.71)	1805.90 (1371.55)
Class Standing	Freshmen	1500.60 (1846.34)	1031.10 (1120.21)	1760.52 (1447.00)
	Sophomore	1860.06 (2113.48)	1400.19 (1741.90)	1755.86 (1370.58)
	Junior	1579.13 (1716.16)	1150.93 (1089.27)	1615.57 (1293.71)
	Senior	1782.29 (1800.88)	1163.28 (1114.49)	1473.41 (1274.63)
	Other	1332.31 (826.78)	1209.23 (1028.16)	1068.69 (1325.53)
Major	Physical Education/Kinesiology	2473.68 (2100.67) **	1434.47 (1222.94)	1527.21 (1371.74)
	Non-Physical Education/Kinesiology	1487.26 (1767.69)	1109.44 (1272.23)	1680.48 (1362.28)
SES	< $20,000	1565.48 (2025.35)	1153.33 (1152.31)	2002.15(1526.04)
	$20,000 - $49,999	1581.16 (1683.83)	1262.83 (1254.84)	1599.65 (1342.11)
	$50,000 – $99,999	1673.59 (1831.11)	1123.16 (1205.44)	1625.50 (1235.80)
	$100,000 – $199,999	1610.21 (1851.19)	1037.96 (1081.51)	1651.57 (1375.25)
	> $200,000	1841.67 (1798.75)	1181.29 (1129.92)	1524.20 (1087.07)
	Not Sure	1702.69 (1905.38)	1208.95 (1526.09)	1512.73 (1376.39)
BMI	Underweight	1008.80 (1549.52)	1307.00 (1528.78)	1851.54 (1313.70)
	Normal	1689.47 (1813.45)	1166.19 (1294.11)	1632.96 (1341.15)
	Overweight	1855.27 (2082.58)	1254.10 (1243.51)	1668.36 (1418.66)
	Obese	1153.07 (1572.03)	781.88 (844.56)	1687.52 (1435.46)
Living Status	On Campus	1600.36 (2006.22)	1116.34 (1226.24)	1725.28 (1377.97)
	Off Campus	1672.63 (1793.99)	1187.28 (1289.54)	1623.52 (1358.29)

Table 8: Weekly VPA, MPA, & Walking in METs.

Note: *indicated significant difference at $p < 0.05$ level; ** indicated significant differences at $p < 0.01$ level.

	VPA	MPA	Walking
PE/Kinesiology	2554.67 (2136.06)**	1455.33 (1244.67)	1521.13 (1352.49)
Non-PE/Kinesiology	1551.93 (1759.70)	1121.08 (1179.09)	1661.38 (71.09)

Table 9: Comparison of PA Levels between PE/Kinesiology and Non-PE/Kinesiology Majors.
Note: ** indicates significant difference at $p < 0.01$ level.

Sedentary Time

While 21.82% (N = 206) of the students did not know how much daily sedentary time they had, 29.9% (N = 282) of them indicated more than 8 hours of sitting every day during the past week. The average daily sedentary time in hours reported by the students was 6.43 ± 3.17 in hours. The hours of sedentary time were presented in Table 10. Independent t-test and ANOVA were first used to briefly examine group differences. In general, Asian students reported more sedentary time than African Americans, Caucasians and Latinos ($p < .05$). Students in physical education/kinesiology majors reported less sedentary behavior than other majors ($p = .005$). Freshmen had smallest amount of sedentary time, and the difference was only significant comparing to those in their junior year ($p = .01$). No gender difference was found.

A four-way ANOVA was conducted to explore the effects of gender, ethnicity, major and class standing on sedentary behavior. There were no interaction effects. Only major had a significant effect [$F(1,67) = 9.862$, $p = .002$, $\eta^2 = .015$], indicating a lower prevalence of sedentary behavior among students in physical education/kinesiology majors. Comparison of sedentary time by major was presented in Table 11.

		Weekly Sedentary Time
Total		6.43 (3.17)
Gender	Male	6.54 (3.15)
	Female	6.37 (3.19)
Ethnicity	African American	6.32 (3.04)
	Asian	7.28 (3.53)**
	Caucasian	6.30 (3.01)
	Hispanic/Latino	6.10 (3.04)
	Native American	9.00 (4.24)
	Other	6.67 (3.56)
Class Standing	Freshmen	5.99 (2.84)
	Sophomore	6.67 (3.65)
	Junior	6.80 (3.40)
	Senior	6.57 (2.87)
	Other	6.15 (3.10)
Major	Physical Education/Kinesiology	5.44 (2.95)**
	Non-Physical Education/Kinesiology	6.62 (3.18)
SES	< $20,000	6.32 (8.50)
	$20,000 - $49,999	6.32 (2.92)
	$50,000 – $99,999	6.39 (3.04)
	$100,000 – $199,999	6.96 (3.44)
	> $200,000	6.14 (2.85)
	Not Sure	6.29 (3.47)
BMI	Underweight	6.18 (3.19)
	Normal	6.39 (3.09)
	Overweight	6.33 (3.02)
	Obese	7.28 (4.08)
Living Status	On Campus	6.31 (3.06)
	Off Campus	6.48 3.22)

Table 10: Weekly Sedentary Time in Hours.
Note: *indicated significant difference at $p < 0.05$ level; ** indicated significant differences at $p < 0.01$ level.

	Weekly Sedentary Time
PE/Kinesiology	5.48 (2.97)**
Non-PE/Kinesiology	6.61 (3.18)

Table 11: Comparison of Weekly Sedentary Time between PE/Kinesiology and Non-PE/Kinesiology Majors.
Note: ** indicated significant differences at $p < 0.01$ level.

PA Recommendation Knowledge

Four multiple choice questions were used to test students' understanding on recommended PA for adults. The total number of students who completed the questions were 974. In questions regarding recommended amount of moderate-intensity aerobic activity, vigorous-intensity aerobic activity, and duration of aerobic activity, only a small percentage of students were able to answer correctly (37.1%, 21.8%, and 13.3%, respectively) (see Table 12-a). While they did not have adequate knowledge on aerobic activities, the students were more likely to know the recommended amount of muscle-strengthening activity per week (i.e. 51.1%). It was found that 27.5% students did not answer any of the questions correctly, while only 1.9% student answered all the four questions correctly. Correlations among the scores for each question were very low (see Table 12-b). The average of scores for all the four questions were 1.26 ± 1.01, indicating a very poor understanding of the PA recommendations (see Table 13). Independent t-test and one-way ANOVA was first used to briefly examine group differences. No differences were observed except for major, as students in physical education/kinesiology majors scored significantly higher than the other majors ($p < .001$) (see Table 14).

PA Recommendation	Percentage of Correct Answers
Moderate-intensity aerobic activity	37.1%
Vigorous-intensity aerobic activity	21.8%
Muscle-strengthening activity	51.1%
Duration of aerobic activity	13.3%

Table 12-a: Percentage of Correct Answers for PA Recommendation Knowledge Test.

	1	2	3	4
1. Recommendation on weekly moderate-intensity aerobic activity	1			
2. Recommendation on weekly vigorous-intensity aerobic activity	.263**	1		
3. Recommendation on weekly muscle-strengthening activity	.037	.098**	1	
4. Duration of aerobic activity	.158**	.078**	.007	1

Table 12-b: Correlations of PA Recommendation Knowledge Score on Each Test Item.
Note: ** indicated significant correlations at $p < 0.01$ level

		M (SD)
Total		1.26 (1.01)
Gender	Male	1.23 (0.98)
	Female	1.28 (1.03)
Ethnicity	African American	1.41 (1.08)
	Asian	1.23 (1.00)
	Caucasian	1.35 (1.02)
	Hispanic/Latino	1.40 (0.89)
	Native American	1.11 (0.99)
	Other	1.38 (1.04)
Class Standing	Freshmen	1.16 (1.03)
	Sophomore	1.29 (0.99)
	Junior	1.29 (0.97)
	Senior	1.35 (1.06)
	Other	1.43 (1.02)
Major	Physical Education/Kinesiology	1.64 (1.04)**
	Non-Physical Education/Kinesiology	1.19 (0.99)
SES	< $20,000	1.22 (1.06)
	$20,000 - $49,999	1.23 (1.01)
	$50,000 – $99,999	1.23 (1.04)
	$100,000 – $199,999	1.41 (1.04)
	> $200,000	1.53 (0.99)
	Not Sure	1.15 (0.95)
BMI	Underweight	1.20 (1.05)
	Normal	1.26 (1.01)
	Overweight	1.38 (1.04)
	Obese	1.01 (0.98)
Living Status	On Campus	1.26 (1.05)
	Off Campus	1.26 (1.00)

Table 13: Means and SDs for the PA Recommendation Knowledge Scores.
Note: *indicated significant difference at $p < 0.05$ level; ** indicated significant differences at $p < 0.01$ level.

	PA Recommendation Knowledge Test Score
PE/Kinesiology	1.64 (.086)**
Non-PE/Kinesiology	1.19 (.036)

Table 14: Comparison of PA Recommendation Knowledge Test Scores between PE/Kinesiology and Non-PE/Kinesiology.
Note: ** indicated significant differences at $p < 0.01$ level.

Relationships among Awareness, Knowledge and Behavior

Correlations

Pearson's correlation was used for examining the relationships among PA awareness, behavior and knowledge (Table 15-a). The total score of PA awareness was calculated by averaging the scores of the four awareness components. The results indicated positive significant correlation between PA awareness and total PA ($r = .325$, $p < .01$), as well as PA awareness and knowledge ($r = .220$, $p < .01$). The correlation between PA behavior and knowledge was marginal and insignificant.

Furthermore, the correlations between PA behavior and each PA awareness component were assessed and significantly positive correlations of PA behavior and each component (see Table 15-b). Specifically, the correlations with awareness of physical environment ($r = .242$, $p < .01$) and recommendation knowledge ($r = .246$, $p < .01$) were slightly stronger than the correlations with personal PA levels ($r = .195$, $p < .01$) and social support ($r = .181$, $p < .01$).

	Awareness	Recommendation Knowledge	Behavior
Awareness	1		.
Recommendation Knowledge	.220**	1	
Behavior	.325**	.061	1

Table 15-a: Correlations of Awareness, Recommendation Knowledge and Behavior.
Note: ** indicated significant differences at $p < 0.01$ level.

	PA Behavior	Personal PA	Social Support	Environment	Recommendation Knowledge
PA Behavior	1				
Personal PA	.220**	1			
Social Support	.214**	.160**	1		
Environment	.221**	.297**	.332**	1	
Knowledge	.253**	.319**	.324**	.496**	1

Table 15-b: Correlations of PA Awareness Components and PA Behavior.
Note: ** indicated significant differences at $p < 0.01$ level.

Difference of Physical Activity Awareness by Knowledge Group

In order to better understand the relationship between knowledge and awareness, the variable "knowledge score" was recoded into three groups: low-knowledge group (knowledge score = 0), medium-knowledge group (knowledge score = 1~2), and high-knowledge group (knowledge score = 3~4). A one-way MANOVA was conducted to analyze how PA awareness differed among the three knowledge groups. The results indicated a significant effect of knowledge on PA awareness [Wilk's Lambda = .911, $F(8, 1838) = 10.958$, $p < .001$, $\eta^2 = .046$]. The post hoc test indicated group differences in awareness of personal PA levels [$F(2, 922) = 8.416$, $p < .001$, $\eta^2 = .018$], awareness of physical environment [$F(2, 922) = 8.900$, $p < .001$, $\eta^2 = .019$], and awareness of

recommendation knowledge [$F(2, 922) = 37.138$, $p < .001$, $\eta^2 = .075$]. In particular, the low-knowledge group had the lowest levels of PA awareness, while high-knowledge group had the highest levels of PA awareness.

Effects of Gender, Ethnicity, Major and Class Standing on Awareness, Knowledge and Behavior

A four-way MANOVA was conducted to investigate the effects of gender, ethnicity, major, and class standing on PA awareness, knowledge and behavior. The results indicated an interaction effect of major * class standing on the overall dependent variable (awareness, knowledge and behavior) [Pillai's Trace = .020, $F(9,2565) = 1.906$, $p = .047$, $\eta^2 = .007$]. Major had an individual effect on the overall dependent variable [Pillai's Trace = .040, $F(3,853) = 11.921$, $p < .001$, $\eta^2 = .040$]. The post hoc test indicated that major had significant effects on PA awareness $F(1,69) = 31.806$, $p < .001$, $\eta^2 = .036$, and PA behavior, $F(1,69) = 10.241$, $p = .001$, $\eta^2 = .012$. In particular, students in physical education/kinesiology majors had higher levels of PA awareness and participated in more PA. Comparisons of PA awareness, knowledge and behavior by major were presented in Table 16.

	Awareness	**Knowledge**	**Behavior**
PE/Kinesiology	5.42 (.73)**	1.64 (1.05)**	4344.12 (2826)**
Non-PE/Kinesiology	4.45 (.95)	1.19 (.99)	3253.24 (3727.84)

Table 16: Comparisons of Awareness, Knowledge and Behavior by Major.
Note: ** indicated significant differences at $p < 0.01$ level

Path Analysis

Path analysis was conducted to further examine the relationships among awareness components, knowledge, behavior, gender, BMI (raw scores), major, and class standing. Major was recoded into two categories: physical education/kinesiology (major = 1) and others (major = 2). The proposed model (see Figure 9) demonstrated poor model fit as the selected model fit indices were not within the acceptable ranges. Therefore, the model was by correlating error variances of the awareness components, removing BMI, and adding paths among the remaining variables. The final model (see Figure 10) had a good model fit (i.e., RMSR = .045, RMSEA = .058, GFI = .984, NFI = .926, CFI = .941) after model respecification (Table 17).

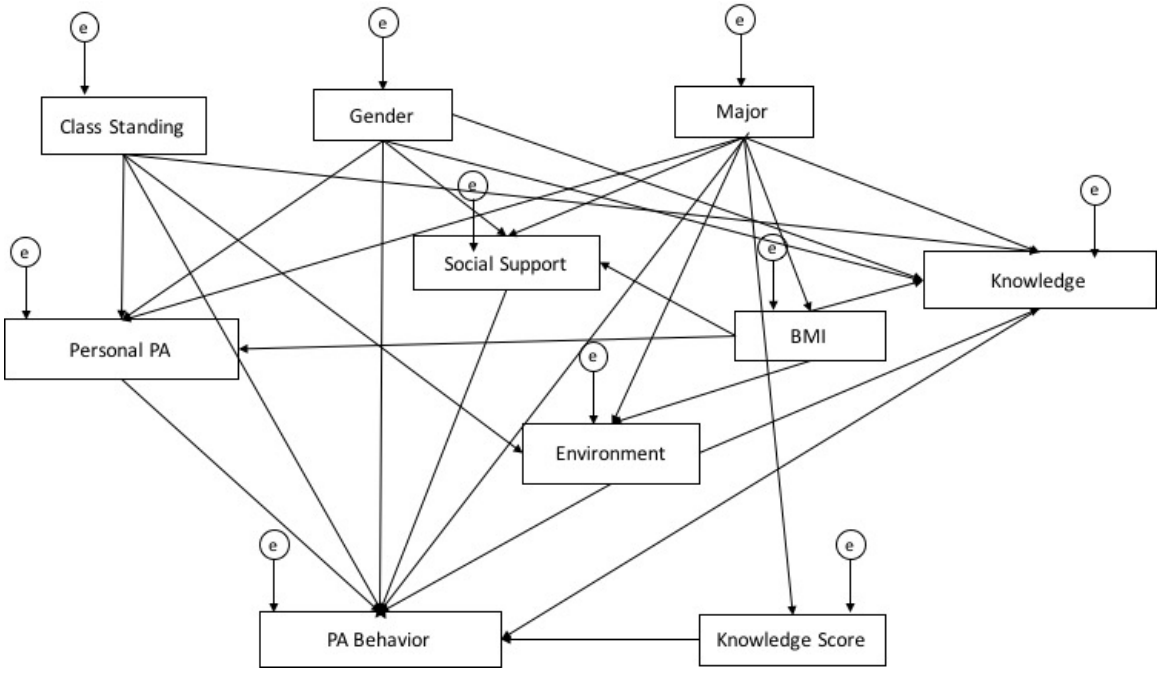

Figure 9: Path Analysis (Proposed Model).

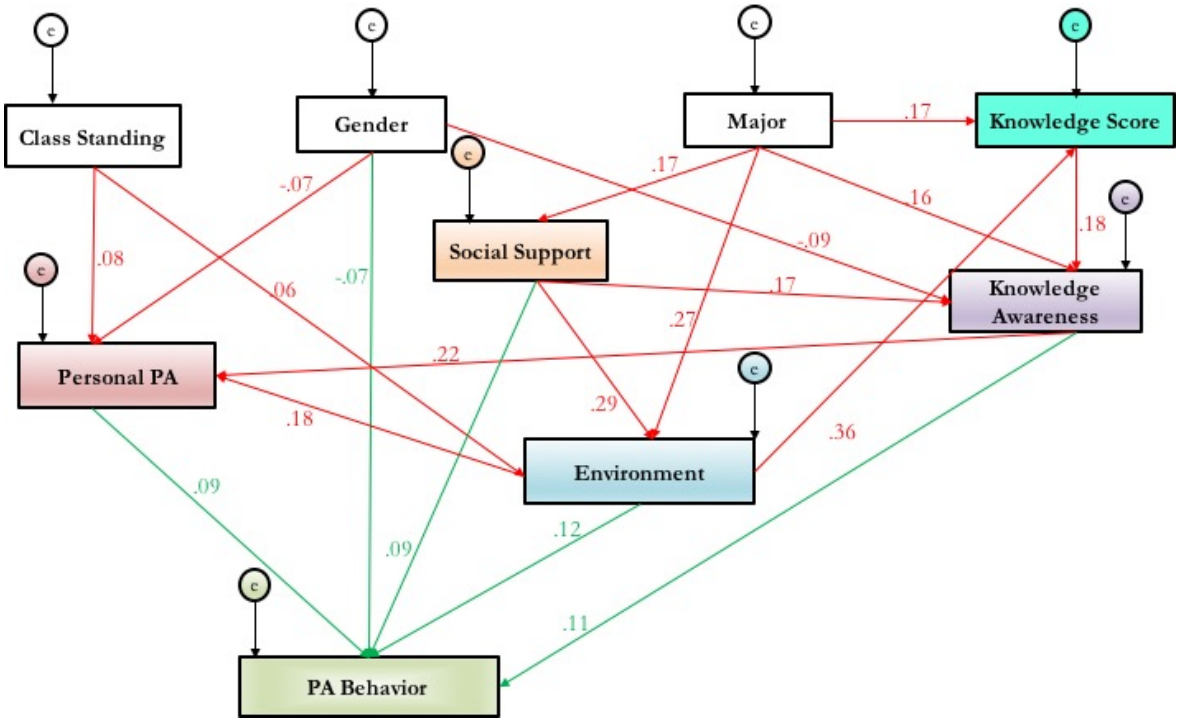

Figure 10: Path Analysis (Final Model).

Factor Model	RMSR	RMSEA	GFI	NFI	CFI
Original	.050	.100	.977	.886	.892
Respecified	.045*	.058*	.984**	.926*	.941*

Table 17: Model Fit Indices for Path Analysis.
Note: * indicated acceptable model fit; ** indicated excellent model fit.

All four components of PA awareness had significant positive direct effects ($p <$ .01) on PA behavior. Gender had a significant effect on PA behavior ($p = .017$). Major had significant direct effects on all the PA awareness components except for personal PA

assessment without direct effects on PA behavior. Meanwhile, awareness of physical environment, recommendation knowledge and social support mediated the indirect effect of major on PA behavior. Additionally, major had a significant direct effect ($p = .002$) on PA knowledge. Standardized total effects were presented in Table 18.

Major. The results indicated major had indirect effects on PA through the mediation of awareness of environment ($p < .001$), knowledge ($p < .001$), and social support ($p < .001$). Specifically, students in physical education/kinesiology major had higher levels of awareness in these three components, which may lead to higher levels of PA engagement.

Gender. Gender had a significant direct effect on PA (p = .017). In addition, gender indirectly effect PA through the mediation of awareness in personal PA ($p = .016$) and recommendation knowledge ($p < .001$). It was found that male students were more aware of their personal PA levels and PA recommendation knowledge, which lead them to participate more in PA behavior than their female counterparts.

Class Standing. Class standing had indirect effects on PA through the mediation of awareness in personal PA ($p = .01$) and environment ($p < .001$). The results indicated students in more advanced class standing were more aware of their personal PA levels and Pa opportunities in the environment, therefore had higher levels of PA engagement.

Recommendation Knowledge. The score of PA recommendation knowledge test only had a indirect effect on PA through the mediation of knowledge awareness ($p < .001$).

Path			Estimate	P
Awareness of Personal PA	<---	Gender	-.073	.016
Awareness of Personal PA	<---	Class Standing	.078	.010
Awareness of Personal PA	<---	Awareness PA Recommendation Knowledge	.217	<.001
Awareness of Personal PA	<---	Awareness of Physical Environment	-.180	<.001
Awareness of Social Support	<---	Major	.166	<.001
Awareness of Physical Environment	<---	Major	.269	<.001
Awareness of Physical Environment	<---	Class Standing	.062	.034
Awareness of Physical Environment	<---	Awareness of Social Support	.288	<.001
Awareness of PA Recommendation Knowledge	<---	Gender	-.088	<.001
Awareness of PA Recommendation Knowledge	<---	Major	.163	<.001
Awareness of PA Recommendation Knowledge	<---	Awareness of Social Support	.169	<.001
Awareness of PA Recommendation Knowledge	<---	Awareness of Physical Environment	.362	<.001
Awareness of PA Recommendation Knowledge	<---	PA Recommendation Knowledge Score	.182	<.001
PA Recommendation Knowledge Score	<---	Major	.168	<.001
Total PA	<---	Awareness of Personal P	.094	.004
Total PA	<---	Awareness of Social Support	.091	.007
Total PA	<---	Awareness of Physical Environment	.122	<.001
Total PA	<---	Awareness of PA Recommendation Knowledge	.114	.002
Total PA	<---	Gender	-.075	.017

Table 18: Path Analysis Standardized Total Effects.

DISCUSSION

As noted earlier, the primary purpose of the study was to investigate college students PA awareness, knowledge and behavior, and the relationships among these variables. This section discussed the results of the current study by research questions, followed by limitations of the study. Implications for future research were also addressed.

Research Question 1: What are the effects of gender, ethnicity, major and class standing on Students' PA awareness?

In answering the first question, a survey was used to assess students' levels of PA awareness. The means of PA awareness components were first discussed and effects of the independent variables were then discussed.

PA Awareness

The results suggested that college students were slightly aware of their own PA levels, social support, physical environment and recommendation knowledge. Given that the study made a first attempt to to measure PA awareness among college students using a newly validated scale, it was difficult to find criteria from previous studies to make an assertion on the degree of their awareness. However, the average scores ranging around 4.20 to 5.24 on a 7-point scale, indicated a relatively weak to moderate PA awareness among the college students. Specifically, college students' PA awareness was assessed comprehensively in four components as continuous variables, adding the richness of the data and allowing for more statistical analyses to explore the relationships. Previous

studies usually measured PA awareness in percentages of correct statement related to PA or used self-reported PA interchangeably (Berry, Nolan, & Dollman, 2016; Corder et al., 2010; van Sluijs, Griffin, van Poppel, 2007). Therefore, this study provided meaningful data that could be analyzed to gain a more comprehensive understanding on this topic.

The average score of awareness of personal PA levels was highest among the four components, indicating that the students were slightly more focused on their own behavior as opposed to external influences. It also indicated that students relatively perceived themselves to be confident in their estimating their PA levels. With health benefits of regular PA participation being repetitively stated, it is critical for students to accumulate sufficient amount of PA throughout the day, especially they are expected to sit for quite long for studying. Therefore, the ability of accurate self-evaluation is key in developing one's PA habits (Corbin, 2002). The importance of self-evaluated PA was supported in a previous study on college students' attitudes towards PA assessment, finding that a majority of students agreed to have PA participation be counted as part of their course grade (Wen & Tsai, 2006). The importance of self-assessing skill has also been emphasized by educators in the Corbin's (2002) curriculum model of "stairway to lifetime physical activity and fitness". The author suggested that all physical educators must teach students how to self-assess so they would become independent physically active individuals for a lifetime (Corbin, 2002).

Awareness of social support was found to be at a moderate level among all the components, with no significant differences across various groups. The motivational role of social support in PA participation has been supported by handful of studies (Barfield &

Hutchinson, 2012; Belanger & Patrick, 2018; Farren, Zhang, Martin, Thomas, 2015; King, Vidourek, English, & Merianos, 2014; McNeil, Kreuter, & Subramanian, 2006; Pauline, 2013, Zick et al., 2007). The finding that all students in this study were moderately aware of support from their family, friends, peers and professors regardless of their gender, ethnicity, major and class standing, indicated college students' consistent need of being supported by others in PA participation. In college setting, students oftentimes perceive PA as organized sports or shared activities with friends and peers, making social support an important factor to be considered as they make decisions regarding to PA (Burke, Carron, & Eys, 2006; Resnick, Janney, Buis, & Richardson, 2010).

The results revealed a relatively higher level of environment awareness, indicating a considerable amount of perceived importance of PA environment for college students. In addition, the level of environment awareness differed by year and major, suggesting the significant impact of college experience and educational intervention on shaping the extent to which students involve evaluation of elements in the environment for decision making in PA (Gustat et al., 2014; Heath et al., 2012). The findings are consistent with previous research suggesting the influential role of environment characteristics on PA behavior (Ford & Torok, 2008; Kapinos & Yakusheva, 2011; Pan et al., 2009; Roemmich, Balantekin, & Beeler, 2015). More importantly, in a meta-analysis by Duncan and colleagues (2005) reported that the perceived the PA environment had a great impact on PA, which is confirmed in this study that with all

available facilities and services on campus, college students should be aware of the resources to better make personalized action plan to increase PA participation.

Awareness of PA recommendation was found to have a lowest average score among all the four components. This finding is in line with previous studies reported recommendation awareness in percentage and demonstrated low prevalence of awareness (i.e. 37.3% in Canada, 12.3% in Japan, and 36.1% in US) among general populations in different countries (Cameron, Craig, Bull & Bauman, 2007; Harada, Shibata, Lee, Oka, & Nakamura, 2011; Kay, Carroll, Carson, & Fulton, 2014). Previous studies found the relationships between awareness of PA recommendation and PA behavior to be ambiguous as a number of cross-sectional studies reported positive associations (Cameron et al., 2007; Harada et al., 2009; Plotnikoff et al., 2011), while, none significant relationships were reported in longitudinal studies (Higo & Nakamura, 2008) and interventional studies (Kliman & Rhodes, 2008; Plotnikoff, Todosijczuk, Johnson & Karunamuni, 2012). Nevertheless, this study revealed a significant direct effect of recommendation knowledge awareness in PA behavior, which will be discussed in more details in the later paragraphs.

Effects of Major

The higher correlations between total PA and the awareness of environment and recommendation knowledge suggested the greater importance of knowing the environment and recommendation knowledge in decision making and PA participation. The significant effect of major in the four-way MANOVA suggested higher levels of

awareness of environment and recommendation knowledge among physical education/kinesiology students. Therefore, it is promising to find that students in physical education/kinesiology were more aware of these two important components.

PA Awareness by Gender, Ethnicity and Class Standing

Although the four-way MANOVA results revealed no significant effects of gender, ethnicity, or class standing on PA awareness, the preliminary one-way MANOVA indicated some variations among different groups. Since these factors have been examined repetitively in research on PA behavior, it is deemed necessary to compare these results with previous PA research to better interpret PA awareness found by the current study.

Gender. The MANOVA did not report any gender effects. However, the one-way MANOVA found that male students seemed to be more likely to pay attention to their personal PA levels and the PA recommendation knowledge than female students. A number of studies have also found the same difference between males and females on PA participation across different age groups (Belcher et al., 2010; Hagströmer, Oja& Sjöström, 2007; Troiano et al., 2007; Vilhjalmsson, R., & Kristjansdottir, 2003). Previous research examining college students' participation in sports and exercise suggested that male students were more motivated by challenge and competition (Kilpatrick, Hebert, & Bartholomew, 2005; Egli, Bland, Melton, & Czech, 2011). Therefore, male students were more likely to pay attention to criteria-related aspects, such as higher awareness in personal PA levels and recommended PA levels.

Ethnicity. Although ethnicity did not have an effect on awareness, the group means suggested some variations of PA awareness among the ethnicity groups. In general, African American and Caucasian students' PA awareness was relatively higher, while Asian students' awareness of all the components was the lowest among all ethnicity groups. Hispanic/Latino, which was the second largest student body in the sample, had moderate levels of PA awareness. It is possible that such differences were caused by ratio of major within each ethnicity groups. In particular, among all African American students in this study, 40.74% of them claimed to be physical education/kinesiology majors, while only 5% of the Asian students categorized themselves in this major. In addition, from the culture perspective, Asian students are more or less influenced by the Asian culture that values academic success (Xie, & Goyette, 2003). Such attitudes and beliefs may have deemphasized the importance of PA among the Asian students (Lee & Zhou, 2014).

Class Standing. When comparing PA awareness among students of different class standings, the awareness levels in all components were likely to increase along with their year of college, with the exception for social support, which did not show much difference and was only higher for senior students. This might be explained in that the longer they had stayed in college, the more education they received from physical education or health-related college courses that improved their self-management skills for better self-monitoring their own PA levels, as well as understanding PA knowledge (Annesi, Porter, Hill, & Goldfine, 2017). Additionally, senior students had more experience in various campus activities, which increased their familiarity with the

campus environment for PA participation (Durand, Andalib, Dunton, Wolch, & Penz, 2011; Gustat et al., 2014; Heath et al., 2012).

In summary, the results partially supported the hypothesis by presenting a major effect on college students' PA awareness. The influence of major on PA awareness was found to be critical, suggesting the importance of physical education in providing essential knowledge so students know what levels of PA are needed and how to improve PA participation using various external resources and assistance.

Research Question 2: What are the relationships among PA awareness, knowledge, and behavior?

In order to answer the second research question, results of PA knowledge and PA behavior were first discussed to provide basic understandings of these two variables. The comprehensive relationships among awareness, knowledge and behavior were then discussed, considering other various factors such as gender, ethnicity, major and class standing.

PA Behavior

It is surprising to find that half of the students scored "high" on the IPAQ short form, which was inconsistent with previous findings (Cocca, Liukkonen, Mayorga-Vega, & Viciana-Ramírez, 2014; Pengpid et al., 2015). However, given that PA was measured subjectively, the seemly large percentage of "high" PA levels might be that students overestimated their PA using the self-reported method (Lechner, Bolman, & van Dijke, 2006; van Sluijs et al., 2007). It is also possible that those who chose to participate in the study were more physically active, resulting in a sample of highly active participants.

Nevertheless, the possible overestimation of self-rated PA suggested that the students need to have more knowledge and skills to be able to evaluate PA accurately. It is often suggested that the transition from high school to college life is a crucial period when students undergo emotional, physiological and environmental changes, therefore their lifestyle changed too such as decreased PA (Cocca etal., 2014; Gallardo-Escudero, Muñoz, del Pozo Planells, & López, 2014). A study examining college students' PA in 23 countries reported a physical inactivity rate of 40% (Pengpid et al., 2015). The possible overestimation of self-rated PA in this study warrants the importance of raising self-awareness of PA as a first step for PA promotion, as failure to recognize behavioral inadequacy is not beneficial for improvement (Larhart, Reichl, Metsios, Nevill, & Carmichael, 2014; van Stralen, Lechner, Mudde, De Vries, & Bolman, 2010).

The association between gender and PA levels reflected the literature in that male students were more active (Clemente, Nikolaidis, Martins, & Mendes, 2016; Haase, Steptoe, Sallis, & Wardle, 2004; Wallace, Buckworth, Kirby, & Sherman, 2000; Ramos-Jiménez, Hernández-Torres, Urquidez-Romero, Wall-Medrano, & Villalobos-Molina, 2017). For college students, VPA may be reinforced more among male students through their participation in men's intramural sports and conditioning classes (Buckworth & Nigg, 2004). Additionally, students in physical education/kinesiology majors may be required to take a variety of PA-related courses, resulting in more opportunities to participate in VPA through class-based sports and activities. Furthermore, according to self-efficacy theory (Bandura, 1997), students in these majors were trained to have better physical skills comparing to the other majors, and they gained more confidence from the

PA classes. These influences might have carried over to their daily life because of increased self-efficacy and personal motivation, which advanced their PA levels (Annesi et al., 2017).

Students reported over 6 hours of sedentary time per day, indicating a total amount of over 40 hours per week engaged in sedentary behaviors, which was relatively high compared to what has been reported in the literature (Buckworth & Nigg, 2004). The contribution of sedentary behavior to physical inactivity is not clear. However, with specific time constraints related to college students' academic schedules, it is possible that studying is associated with increased sedentary time, which subsequently taking away the time they could be engaged in PA participation (Epstein & Roemmich, 2001). It is not surprising to find that physical education/kinesiology major had less sedentary time given the relatively higher amount of PA time as part of their major studies.

PA Recommendation Knowledge

Four multiple choice questions were used to assess students' knowledge about PA recommendations. The questions were extracted from an official document by WHO (2010), that provided recommended PA levels for each age group with specific explanations. Therefore, the content of the questions was considered authoritative. The average knowledge score was very low, indicating limited uptake of the PA recommendations among college students, especially for VPA and MPA (Berry et al,

2016). Thus, the results highlight the importance of better understanding the correlates of students' uptake of the internationally endorsed PA recommendations in future research.

Specifically, over half of students were able to accurately identify the weekly recommendation on muscle-strengthening PA, while their knowledge about aerobic activities was relatively lower. This indicates the popularity of muscle-strengthening PA among the students, which was also confirmed in Study I, reporting an emphasis on strength activities such as weight training when students described their PA experience. It is suggested that students associated strength activities with body image satisfaction, which is found to be a reliable indicator of PA participation (Garrusi, Garousi, & Baneshi, 2013; Ramos-Jiménez et al., 2017). It also explains why students with better knowledge were more aware of their environment as much of the strength activities involved the use of gym facilities and equipment, as well as enrollment in PA courses provided on campus.

As expected, significant difference in knowledge scores was observed between physical education/kinesiology majors and the non-physical education/kinesiology majors. However, no differences were found by gender, ethnicity, or class standing. It is reasonable to conclude that students in physical education/kinesiology majors enrolled in more instructional PA courses than other students as part of their degree requirement. Therefore, they were more likely to be exposed to PA opportunities and receive more benefits that went beyond higher levels of PA awareness and behavior, but also knowledge acquisition (Annesi et al., 2017).

Although no significant effects of gender or class standing were found in this study, students' knowledge seemed to be slightly increased by their year in school, and female students had slightly better scores than their male counterparts. Similar findings were reported in a previous study that examined PA recommendation knowledge among the general population in US, reporting a positive association between age and recommendation knowledge, and that women were more likely to identify the correct answers due to more concerns about health risks (Bennett, Wolin, Uleo, Mâsse, & Atienza, 2009). Another potential reason for the slight increase of knowledge by class standing could be that the longer the students attended the university, the more likely they might have been exposed to instructional PA courses, which provided a great venue for disseminating PA knowledge as 87% of 4-year universities offer instructional PA classes for general students (Annesi et al., 2017; Strand, Egeberg, & Mozumdar, 2010). Therefore, it is suggested that universities not only provide such courses, but also make it as a recommendation or requirement for students, especially for those who are sedentary and lack self-efficacy.

Given the consistent evidence of PA disparities by ethnicity group, it was surprising to find no significant variations in PA recommendation knowledge in this study. It might be possible that the frequently observed differences in PA by ethnicity was not accounted for by knowledge disparities (Bennett et al., 2009). More research on the relationship between PA knowledge and behaviors is needed.

Relationships among Awareness, Knowledge and Behavior

The level of total PA awareness was found to be positively associated total PA levels, suggesting the critical role of awareness on behavioral decision making. Moreover, the positive association between awareness score and knowledge score confirmed the influence of accurate knowledge on one's self-awareness of the behavior. In addition, the awareness may have gone well beyond the reflection of their own behavior, and extended to examination of the external environment where they could seek support from friends, peers and parents, and look for PA opportunities.

The PA recommendation knowledge was not associated with PA behavior, suggesting that knowledgeable students did not necessarily accumulate sufficient PA as recommended. It is possible that when students perceive the recommendation to be unachievable, their motivation to increase PA may be hindered (Bennett et al., 2009). It should be noted that PA levels might have been overestimated by the students. Besides the aforementioned limitation of using self-reported questionnaire to measure PA, poor knowledge might have also contributed to the overestimation issue, which was consistent with previous studies, suggesting the need of accurate information to in self-evaluation of one's PA behavior (Berry et al., 2016; Larhart et al., 2014; van Stralen et al., 2010). Although knowledge alone may not lead to sufficient behavioral change, the results of this study suggested a considerable contribution of PA recommendation knowledge in raising PA awareness, which may subsequently prompt the students to become intentionally more active.

Achieving the recommended PA is beneficial for overall health and well-being (WHO, 2010), therefore, those who are more concerned about personal health are possibly more likely to engage in PA to prevent risks. This association was found to be stronger in older adults, who are more likely to heave health problems (Mathews et al., 2010). However, for college students who are the among the younger population, motivations of PA are not only limited to maintaining good health, but also include weight loss, and better physical appearance (MacLachlans & Haggers, 2010, Milroy et al 2015). Therefore, in order to obtain desirable outcomes, it is possible that they engage in more PA than what is recommended, even though they do not have the correct knowledge of PA recommendation.

The interaction effect of major and class standing indicated the different trends of PA behavior change were observed between physical education/kinesiology majors and other majors. Similar findings were reported in previous research that PA awareness and knowledge increased as students stayed longer in college with more exposure to PA related educational and recreational resources (Annesi et al., 2017). Unfortunately, the prevalence of PA decrease among non-physical education/kinesiology students was consistent with previous studies (Keating, Guan, Piñero, & Bridges, 2005; Racette, Deusinger, Strube, Highstein, & Deusinger, 2008). It was interesting to find a major boost of PA engagement among the sophomores who were not physical education/kinesiology majors. Their PA levels were found to be at peak among all class standings, and slightly lower than the sophomores in physical education/kinesiology majors. Such short-term increase of PA may be interpreted as an instant reaction to

unpleasant changes of body image and perceived physical appearance, as accumulating evidence is available showing a considerable amount of weight gain during the first year in college due to many lifestyle changes during the transition period (Gillen & Lefkowitz, 2011; Gropper et al., 2011; Loyd-Richardon, Lucero, Dibello, Jacobson, & Wing, 2008; Racette et al., 2008). The results suggested that in order to maintain a long-term physically active lifestyle, students' awareness should not be limited to some instant outcomes such as weight loss or muscle building. Instead, knowing the PA recommendations for maintaining sound health should be beneficial for incorporating sustainable lifestyle changes throughout the academically stressful college years (McAuthur & Raedeke, 2009; Racette et al., 2008).

A further path analysis confirmed the proposed model to holistically examine the role of PA awareness, knowledge, and students' characteristics in PA behavior. All the PA awareness components were found to have direct positive influence on PA engagement, which is consistent with previous findings that revealed the individual, social, environmental influence on PA levels (Clemente et al., 2016; Pan et al., 2009). Several insightful results are addressed in the following paragraphs.

Among the four PA awareness components, environment awareness was found to have complex influences in that it both directly and indirectly affected PA participation. Specifically, environment awareness mediated the effects of personal PA level awareness and knowledge awareness, implying the necessity of recognizing available resources and opportunities as cues to raise process. It has been suggested in the self-regulation theory, that the environment could potentially direct one's intention and subsequently lead to

behavioral change. Moreover, the direct influence of class standing on environment awareness suggested college students, especially freshmen, need to pay more attention to the new campus environment as early as possible, and fully make use of available PA resources throughout the four years in college.

Another important awareness component is social support as it also demonstrated two indirect pathways to total PA through the mediation of environment awareness and knowledge awareness. As noted earlier, environment awareness played a critical role in the model, while the direct pathway from social support awareness to environment awareness identified a starting point for raising awareness: social communication. Discovering PA resources in a new environment could be challenging, while receiving information from social network may expand one's sight and exposure to PA opportunities (Resnick et al., 2010). With development of new technology in PA promotion, the influence of social support awareness is no longer distance or space restricted (Consolvo, Everitt, Smith, & Landay; 2006; Heath et al., 2012; Resnick et al., 2010; Toscos, Consolvo, & McDonald, 2011).

Lastly, knowledge awareness also had an indirect effect on PA through the mediation of personal PA awareness. According to the self-awareness theory, awareness takes place based on the recognition of the discrepancy between self and standards (Duval & Wicklund, 1972). Therefore, the PA recommendation is suggested to be the fundamental knowledge that worth reinforcing among college students (Normand, 2008; Zhang et al., 2016).

LIMITATIONS

There were several limitations in the study. First, completing the IPAQ may have prompted the participants to specially think about their PA, which may consequently lead to inflated awareness of personal PA level (Lechner, Bolman, & van Dijke, 2006; van Sluijs et al., 2007; van Sluijs, Poppel, Twisk, & van Mechelen, 2006). Therefore, the IPAQ data were collected after the awareness scale in order to control for this potential bias. Second, the assessment of PA behavior was restricted to self-reported data, which might have led to students' overestimation on their PA levels, especially among those who reported low awareness in personal PA. Although it was a validated questionnaire for subjectively measuring PA, self-reported PA is known to be weakly correlated with overall energy expenditure and may lead to social desirability (Adams et al., 2005; Sallis & Saelens, 2000). The effect of this potential bias was difficult to assess at this point. Future research should include objective measures of PA to collect more accurate data. Third, the study took place mainly in one state of the U.S. and the majority of the participants were from two large state universities, lacking variation of campus environment characteristics. Further studies need to take specific examination of campus environment into consideration to validate students' responses to their awareness of the environment.

Despite the above limitations, this study had some strengths in that it used a validated scale to quantitatively measure the levels of PA awareness encompassing four aspects, allowing for variation in responses. The data collection involved a complex set of continuous variables including true PA recommendation knowledge scores and self-

rate PA, allowing for a variety of examinations on the relationships among those variables. Additionally, a large sample size was secured to generate statistically meaningful and robust results. Overall, this study made the first attempt to explore college student PA awareness in the context of college setting. Moreover, the study provided supporting evidence of awareness-behavior pathways through the investigation of underlying relationships among awareness, knowledge and behavior with inclusion of some important characteristics for college students.

CONCLUSIONS AND IMPLICATIONS

University and college communities are a critical setting in which students learn, live, work and develop lifetime health-related skills. Given the large amount of university enrollment and increasing prevalence of physical inactivity among the population, universities have the best opportunities to intervene. This would require university administrators to understand whether students are aware of the supports and constraints for regular PA participation on campus. It is essential that universities continue to explore innovative strategies that meet students' specific psychosocial needs to promote the recommended PA levels and raise PA awareness. Examining PA awareness and the relationship with PA behavior may help identify areas that help increase PA awareness and participation.

This study found that the college students' PA awareness was less than favorable. Nevertheless, the positive direct effects of PA awareness on PA behavior shed light on

future endeavor to promote PA targeting this special group of young adults who spend most of their time on university campus.

Overcoming low awareness of the PA requires collaboration among those from physical education and health profession, university staff and academic sectors to implement specific lifestyle approaches to meet recommended PA. Professors and instructors in health and PA courses should aim to provide long-term influence on students' PA habits by teaching them essential knowledge and reinforcing the values of the PA recommendation and regular participation. Especially for PA courses in which organized activities and sports take place, instructors may consider fostering the social interaction through shared activities to provide students a sense of skill mastery and social support. Meanwhile, universities should decrease accessibility and rewards of sedentary activities on campus by providing more quality and approachable PA resources along with disseminated information about those resources to increase PA environment awareness among the students. Furthermore, the academic sector may consider reinforcing PA policies such as recommending or requiring credits in physical education courses in order to promote PA in this particular population.

Another suggestion for raising PA awareness is to encourage the use of wearable devices that allow students to self-monitor their own PA levels and receive immediate feedback (Lubans, Morgan, Tudor-Locke, 2009; McClaran, 2011). Additionally, making the collected PA data accessible by the university, may help course instructors or program directors to modify their courses, programs and facilities to reinforce the value of regular PA participation. Moreover, the objectively measured PA data should be used

to validate the relationships among awareness, knowledge and PA behavior found by the current study.

Appendix

Appendix A
Informed Consent Form (Focus Group)

To Project Participant:

You're invited to take part in a research project conducted by Dr. Xiaofen Keating and Rulan Shangguan at the University of Texas at Austin. In this study we hope to develop a valid and reliable instrument to test physical activity knowledge and awareness among college students. You were selected to participate in this study because you are an undergraduate student who is age 18 or older. We hope that our research will lead to better understanding of college student physical activity knowledge and awareness and their relationships with physical activity behaviors.

If you agree to participate in the focus group interview, you will need to sit with five other students in a group to have an open discussion about your physical activity experiences. A moderator will be present with the participants to facilitate the discussion and take notes. You will complete a simple survey regarding general demographic information and basic exercise behaviors. The group interview will take about 60 minutes. The interview will be audio recorded. One possible risk is the confidentiality regarding your own opinions during the group discussion.

All information gathered in this study will remain confidential and be given out only with your permission or as required by law. Your name will not be used at any time. The collected data and consent forms will be kept in separate locked locations for three years.

If you have any questions about this research at any time, please email Rulan Shangguan at rulan@utexas.edu, or contact the Principal Investigator Dr. Xiaofen Keating either at xk93@austin.utexas.edu or at 512-232-3565. You can also contact the Office of Research Support at 512-471-8871 or at orsc@uts.cc.utexas.edu with any concerns or questions about your rights as a research participant.

Thank you for your time!

By signing this consent form you indicate that you have read the form and agree voluntarily to participate in this study. If you choose not to take part, there will be no penalty or loss of benefits to which you are entitled. If you agree to take part, you are free to withdraw from it at any time. Likewise, no penalty or loss of benefits to which you are otherwise entitled will occur.

I agree to participate.

_____ _____

Signature Date

Appendix B
Focus Group General Information
The survey was designed to collect general information. Please provide detailed information about yourself following the questions. No personal data will be revealed to public.

1. EID _____
2. Email address _____
3. Age _____
4. Gender
    a. Male
    b. Female
5. Ethnicity
    a. African American
    b. Asian or Pacific Islander
    c. Hispanic or Latino
    d. Native American
    e. Mixed-ethnicity
    f. Others
6. Major
    a. Physical Education Major
    b. Non-Physical Education but Health-related Major
    c. Neither Physical Education nor Health-related Major
7. Year in college
    a. Freshmen
    b. Sophomore
    c. Junior
    d. Senior
    e. Post-graduate
    f. Other
8. Previous sport experience
    a. None
    b. Recreational activities (lifestyle engagement)
    c. Competitive sports engagement
9. Hours taken in PE/Fitness-related classes _____

10. Major transportation to class
    a. Walking
    b. Biking
    c. Bus
    d. Driving
    e. Others _____

11. How many hours do you have to work per week?
    a. 0
    b. 0-10 hours
    c. 10-20 hours
    d. > 20 hours

12. Do you have any health-conditions that influence your participation in physical activity?
    a. Yes
    b. No

Appendix C
Informed Consent Form (Survey)
Dear Participant,

You are invited to participate in a research study on **"college student physical activity knowledge and awareness"**. This survey is designed to collect data on how well you understand your physical activity behavior and related factors in your campus environment. You are selected to participate because you are identified as a full-time undergraduate student in a 4-year university.

There are minimal risks associated with the study. The survey will take some of your time and cause you to think about your physical activity behavior which could affect your behavior positively or negatively. You will not receive any direct benefits from participating in this study. Reports resulting from this study will not identify you as a participant. All information gathered from you will remain confidential and be given out only with your permission or as required by law. The collected data will be kept in a password-protected device for 3 years.

If you have any questions about this survey at any time, please feel free to contact the researcher Rulan Shangguan by phone at 405-385-1464 or email at rulan@utexas.edu, or Xiaofen Keating at xk93@austin.utexas.edu. For questions about your rights or any dissatisfaction with any part of this study, you may contact, anonymously if you wish, the Institutional Review Board by phone at 512-471-8871 or email at orsc@uts.cc.utexas.edu.

Sincerely,
Rulan Shangguan
Physical Education Teacher Education, University of Texas at Austin

By signing this form, you indicate that (1) you have been informed about this study, and (2) you consent to participate in this study.

Name _____ Date _____

Appendix D-1: Physical Activity Awareness Scale (30-item, before validation)
Thank you again for participating! Please refer to the following information for your understanding of physical activity and types of physical activity.
Physical Activity is defined as any bodily movement produced by skeletal muscles that requires energy expenditure.

Terminology	**Moderate** physical activity	**Vigorous** physical activity	**Muscle**-strengthening physical activity
Definition	activity that requires a moderate amount of effort and noticeably accelerates the heart rate	activity that requires a large amount of effort and causes rapid breathing and a substantial increase in heart rate	physical activity that increases skeletal muscle strength, power, endurance, and mass
Level of exhaustion (0-10 scale)	5-6	7-8	N/A
Example	brisk walking, dancing, swimming, bicycling on a level terrain	jogging, single tennis, swimming continuous laps, bicycling uphill	strength training, resistance training, muscular strength and endurance exercises

Please answer question **1-6** by circling the number that most applies to you.
For example:

Strongly disagree	**Disagree**	**Somewhat disagree**	**Neither agree nor disagree**	**Somewhat agree**	**Agree**	**Strongly agree**
1	2	3	4	5	6	7

1. During a typical week, I KNOW HOW MUCH *moderate* physical activity...

a. I have performed	1	2	3	4	5	6	7
b. I should have performed	1	2	3	4	5	6	7

2. During a typical week, I KNOW HOW MUCH *vigorous* physical activity...

a. I have performed	1	2	3	4	5	6	7
b. I should have performed	1	2	3	4	5	6	7

3. During a typical week, I KNOW HOW MUCH *muscle-strengthening* physical activity…

a. I have performed	1	2	3	4	5	6	7
b. I should have performed	1	2	3	4	5	6	7

4. During a typical week, I KNOW HOW MUCH time I spend *sitting*.

1	2	3	4	5	6	7

5-1. During a typical week, I NEVER assess my physical activity level.

1	2	3	4	5	6	7

5-2. My KNOWLEDGE of different ways to assess my physical activity includes...

a. self-estimation (e.g. reflection, time log etc.)	1	2	3	4	5	6	7
b. technological devices (e.g. pedometer, wristband, smartphone app etc.)	1	2	3	4	5	6	7

6. When I have difficulties with physical activity, I KNOW how to find the needed support from the following people...

a. family members	1	2	3	4	5	6	7
b. friends	1	2	3	4	5	6	7
c. peers	1	2	3	4	5	6	7
d. high school coaches	1	2	3	4	5	6	7
e. professors	1	2	3	4	5	6	7

****

To answer question **7-8**, please refer to this scale:

None at all						A great deal	**Not Applicable**
1	2	3	4	5	6	7	N/A

****
****

7. Please rate HOW MUCH YOU KNOW about the following items in your physical activity environment (e.g. location, schedule, availability, accessibility, capacity, policy etc.).

a. **indoor** physical activity facilities (e.g. gym, pool, lock, shower etc.)	1	2	3	4	5	6	7
b. **outdoor** physical activity facilities (e.g. field, track, pool, court etc.)	1	2	3	4	5	6	7
c. exercise **equipment** (e.g. treadmill, cycle, weights etc.)	1	2	3	4	5	6	7
d. accessible **stairways**	1	2	3	4	5	6	7
e. accessible **sidewalks**	1	2	3	4	5	6	7
f. physical activity **courses** (e.g. weight training, swimming, running etc.)	1	2	3	4	5	6	7
g. conceptual physical education **courses** (e.g. health education, fitness concepts, etc.)	1	2	3	4	5	6	7
h. campus-wide physical education **policy** (e.g. credit requirements etc.)	1	2	3	4	5	6	7
i. group exercise **classes**	1	2	3	4	5	6	7
j. campus-wide **health related events** (e.g. wellness week, running campaign etc.)	1	2	3	4	5	6	7
k. sports **clubs**	1	2	3	4	5	6	7

l. personal **physical activity services** (e.g. fitness trainer, counseling, fitness testing etc.)	1	2	3	4	5	6	7
m. physical activity resource **materials** (e.g. website, brochure, poster etc.)	1	2	3	4	5	6	7

8. Please rate how much you KNOW about physical activity recommendations for young adults on...

a. daily **total** physical activity time	1	2	3	4	5	6	7
b. daily **moderate and vigorous** physical activity time	1	2	3	4	5	6	7
c. frequency of **muscle-strengthening** physical activity per week	1	2	3	4	5	6	7

Appendix D-2: PA Awareness Scale (17-item, validated in Study II)

Personal PA Levels

During a typical week, I know how much _____ I have performed.

1. (self1) moderate physical activity
2. (self2) vigorous physical activity
3. (self3) muscle-strengthening physical activity

PA Recommendation Knowledge

Please rate how much you know about physical activity recommendations for young adults on _____.

4. (standard1) daily total physical activity time
5. (standard2) daily moderate and vigorous physical activity time
6. (standard3) frequency of muscle-strengthening physical activity per week

Environment

Please rate how much you know about _____ in your physical activity environment.

7. (environment1) indoor physical activity facilities
8. (environment2) outdoor physical activity facilities
9. (environment4) accessible stairways
10. (environment6) physical activity courses
11. (environment7) conceptual physical education courses
12. (environment9) group exercise classes
13. (environment11) sports clubs

Social Support

When I have difficulties with physical activity, I know how to find the needed support from _____.

14. (support1) family members
15. (support2) friends
16. (support3) peers
17. (support5) professors

Appendix E: International Physical Activity Questionnaire (IPAQ) Short Form

The following questions (IPAQ-Short Form, 2004) will ask you about the time you spent on being physically active and sedentary in the **last 7 days**. Please think about the activities you do *at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.* Please answer each question even if you do not consider yourself as an active person.

1. During the last 7 days, on how many days did you do vigorous physical activity?
(e.g. heavy lifting, digging, aerobics, or fast bicycling etc.)

_____ days per week

or □ No vigorous physical activities → ***Skip to question 3***

2. How much time did you usually spend doing vigorous physical activity on one of those days?

_____ hours per day

_____ minutes per day

or □ Don't know/Not sure

3. During the last 7 days, on how many days did you do moderate physical activity?
(e.g. heavy lifting, digging, aerobics, or fast bicycling etc.)

_____ days per week

or □ No moderate physical activities → ***Skip to question 5***

4. How much time did you usually spend doing moderate physical activity on one of those days?

_____ hours per day

_____ minutes per day

or □ Don't know/Not sure

5. During the last 7 days, on how many days did you walk for at least 10 minutes at a time?
(e.g. walking at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure)

_____ days per week

or □ No walking → ***Skip to question 7***

6. How much time did you usually spend walking on one of those days?

_____ hours per day

_____ minutes per day

or □ Don't know/Not sure

7. How much time did you usually spend sitting on a week day?
(e.g. time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television)

_____ hours per day
_____ minutes per day
or □ Don't know/Not sure

Appendix F: Physical Activity Recommendation Knowledge Test

The following 4 questions are regarding some of the physical activity recommendations. Please read each statement carefully and circle the letter of the answer based on your own knowledge rather than external resources.

1. Which recommendation is correct about moderate-intensity aerobic activities for substantial health benefits for college students? (i.e. brisk walking, dancing, swimming, or bicycling on a level terrain, etc.)

a. Don't know/not sure
b. At least 150 minutes/week OR 30 minutes/day for 5 days a week
c. At least 300 minutes/week OR 60 minutes/day for 5 days a week
d. At least 60 minutes/day for 5 days a week
e. There is NO recommendation
f. None of the above

2. Which recommendation is correct about vigorous-intensity aerobic activities for substantial health benefits for college students? (e.g. jogging, singles tennis, swimming continuous laps, or bicycling uphill, etc.)

a. Don't know/not sure
b. At least 150 minutes/week OR 30 minutes/day for 5 days a week
c. At least 75 minutes/week OR 15 minutes/day for 5 days a week
d. At least 60 minutes/day for 5 days a week
e. There is NO recommendation
f. None of the above

3. Which one is correct about the recommended duration of aerobic activity?

a. Don't know/not sure
b. Aerobic activity should be performed in bouts of at least 10 minutes duration
c. Aerobic activity should be performed in bouts of at least 20 minutes duration
d. Aerobic activity should be performed in bouts of at least 30 minutes duration
e. There is NO recommendation on minimum duration of performing aerobic activity
f. None of the above

4. Which recommendation is correct about muscle-strengthening activities for college students?

(i.e. strength training, resistance training, and muscular strength and endurance exercises)

a. Don't know/not sure
b. At least 2 days/week
c. No more than 2 days/week
d. There is NO recommendation
e. College students DO NOT NEED any muscle-strengthening activities
f. None of the above

Appendix G: Demographic Information

Please provide following information about yourself.

1. Sex
   □ Male □ Female

2. Age _____

3. Ethnicity
   a. African American b. Asian c. Caucasian
   c Hispanic/Latino d. Native American d. Other, please specify
   _____

4. Height _____ ft _____in

5. Weight _____ lbs

6. Year in College
   a. Freshmen b. Sophomore c. Junior d. Senior
   e. Other, please specify

7. Major
   a. Physical Education/Kinesiology b. Health-related Majors
   c. Liberal Arts d. Business e. Science, Math, Technology
   f. Other, please specify _____ g. Undeclared

8. Living Status
   a. On campus b. Off Campus

9. Major transportation to campus
   a. Driving b. Public transportation c. Bike/scooters
   d. Walking e. Other, please specify
   _____

10. Hours/week spent on paid work (if you have a paid job)
    a. 0 hours b. 0-10 hours c. 10-20 hours d. >20 hours

11. Annual household income

a. <$20,000 b. $20,000-49,999 c. $50,000-99,999

d. $100,000-199,999 e. >$200,000 d. Not sure

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CHAPTER 1-2

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